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DENTAL SURGERY AND PATHOLOGY

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BY

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THE ROYAL DENTAL HOSPITAL

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WITH ILLUSTRATIONS

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PREFACE

Modern research has thrown fresh light on the nature of disease and it is now definitely established that many pathological processes are to be regarded as the natural reaction of the tissues to injury, i.e., injury in the widest sense of the term arising from trauma, physical causes or toxins. The acceptation of this view of disease has had a profound influence on the methods of treatment adopted by the physician and surgeon and the practice of dentistry has been affected in a variety of ways.

Injury from bacterial toxins is by far the commonest of the various forms of injury and the mouth, in an unhealthy state, is one of the most prolific sources of bacterial toxins and, consequently, of disease. The vital importance of maintaining the mouth in a healthy condition thus becomes evident and should constantly be borne in mind by the dental practitioner whose obvious duty is to avoid any operation which may lead to pathological processes in the mouth either directly or indirectly. The line of treatment which he adopts should be based on the etiology and pathology of the condition, and he should bear in mind that the most elaborate technique is not necessarily the most appropriate treatment.

Since the publication of the third edition of this work eight years ago a steady advance has been made towards rational treatment of mouth conditions particularly among the younger generation of dental surgeons. But many practitioners still fail to grasp the serious importance of dental sepsis and dental operations which tend to increase the liability to sepsis are constantly being performed. It is difficult to avoid the conclusion that those who undertake such operations have failed to keep abreast of the advancing science of their profession. So-called " conservative " dentistry aims at the retention of teeth irrespective of whether they are, or may become, a source of sepsis, and is heedless of the prospective danger to the individual which their retention implies; whereas the ideal method of dental treatment should always have in view as its primary object the prevention of disease, and, to this end, it is the duty of the practitioner to take advantage of every opportunity to impress upon his patients the importance of

prophylactic measures. True success in dentistry will only have been achieved when preventable dental diseases have ceased to exist.

The arrangement of the subjects adopted in the third edition has been adhered to in the present issue. A few of the subjects have been considerably altered and extended, particularly the chapter on Irregularities of the Teeth. I have endeavoured to place the causation of irregularities of the teeth on a more satisfactory basis and have classified them under two main groups, namely, those arising from endogenous causes (variations) and those arising from exogenous causes (modifications). Several illustrations have been added with a view of helping the description given of the morbid anatomy of some of the more common types of irregularities. The chapter on Diseases of the Periodontal Membrane contains several new illustrations of morbid anatomy specimens, and a few skiagrams have been given with the object of enabling the student to visualize the morbid anatomy of conditions which he may be required to treat.

The chapter on Fractures of the Jaw has been completely re-written. The limited space devoted to gunshot injuries may cause some disappointment; but these injuries do not form part of the ordinary practice of the dental surgeon.

I have quoted from various authors and the excerpts have been indicated by quotation marks; but I have purposely refrained from giving the source of many of the quotations in order that the attention of the reader may not be distracted, and, in respect of these cases, I trust that the authors will accept this general acknowledgment of the use made of their writings.

Many friends have rendered valuable assistance in the compilation of this work, and I am deeply indebted to Dr. N. Mutch, who contributed the chapter on Bacteriology and whose clear and concise writing will, I venture to think, be very helpful to the student; to Mr. J. Thornton Carter for writing the section on the Eruption of the Teeth, to Dr. G. F. Still for revising the part dealing with Pathological Dentition; to Mr. J. Howard Mummery for his criticism of the chapter on Caries; to Mr. F. Trewby for revising the pages on General Anæsthetics; to Mr. F. N. Doubleday for contributing the section on Local Anæsthesia, and to Mr. H. L. Pickerill for much help in connection with the chapter on Saliva.

I am also under obligations to Messrs. G. Northcroft, J. H. Badcock, G. Chapman, H. Stobie, and L. Guanziroli for much assistance, and I particularly wish to thank my secretary, Miss

M. Wood, for the great help she has given in revising the proof sheets.

For the loan of blocks I am indebted to the Council of the Royal Society of Medicine, the Publishing Committee of the Journal of the British Dental Association, the Medical Committee of the Royal Dental Hospital, Messrs. Claudius Ash and Sons, the Dental Manufacturing Co., Messrs. S. S. White and Co., Messrs. Henry Kimpton and Co., Messrs. Rebman, Messrs. Churchill and Sons, Messrs. P. Blakiston and Sons, Messrs. Baillière, Tindall and Cox, Messrs. Lippincott, Messrs. Hodder and Stoughton, Messrs. Cassell and Co., Messrs. Mayer and Meltzer, and Messrs. Smith, Elder and Co.

Lastly, I have to thank Mr. Henry Bale for his helpfulness and unfailing kindness and to acknowledge the generous assistance which I have always received at the hands of Messrs. Longmans, Green and Co., the publishers of the work.

J. F. Colyer.

January 9, 1919.

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DENTAL SURGERY AND PATHOLOGY

CHAPTER I

Normal Dentition

The Anatomy of Dentition—The Process of Eruption—The Eruption of the Deciduous Teeth—The Absorption of the Deciduous Teeth—The Eruption of the Permanent Teeth

(A) THE ANATOMY OF DENTITION

In the human subject the earliest manifestations of teeth are the enamel organs for the deciduous teeth, which appear during the seventh week of fœtal life, and are followed during the ninth week by the dentine bulbs. At the twentieth week calcification commences with the central and lateral incisors, and at the twenty-fourth week the canines and molars begin to show signs of calcification.

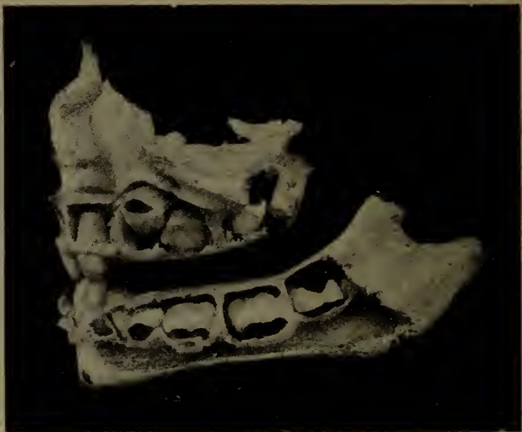
Birth.

Fig. 1.

At birth calcification of these teeth has advanced to the stage shown in fig. 1, and has also commenced in one of the anterior cusps of the first mandibular permanent molar.

At eight months the growth of the deciduous incisors and canines has progressed to the stages shown in fig. 2; the roots of the first molar are commencing to form; the crown of the second molar is almost complete, while in the permanent teeth, calcification has commenced in the incisors and the canines and is well advanced in the cusps of the first molars.

At twelve months (fig. 3) the root of the deciduous canine has commenced to form; growth in the first deciduous molar has progressed beyond the division of the roots and in the second molar almost up to the division; the deciduous incisors are fully erupted and eruption of the first molars has commenced, while in the permanent teeth, about half of the crown of the first molar, the



Eight months.

FIG. 2.

upper third of the crown of the central incisor, about one-fifth of the lateral, and the tip of the canine are formed.

Fig. 4 shows the jaws of a child aged *fourteen months*. The first molars are in place and the canines are partially erupted.

At eighteen months the roots of the central and lateral incisors of the deciduous set are almost complete; about two-thirds of the roots of the canines, practically the whole of the roots of the first molars, and about half the roots of the second molars are calcified. At this period the calcification of the permanent series is as follows:—

The central incisors about three-fourths of the crown.

The lateral incisors (maxillary) about one-fourth of the crown.

The lateral incisors (mandibular) two-thirds of the crown.

Twelve months.

Fig. 3.

Fourteen months.

Fig. 4.

The canines about one-half of the crown.

The first molars a little over three-fourths of the crown.

At two years (fig. 5) the formation of the deciduous teeth is complete, with the exception of the terminal portions of the canines and second molars. In the permanent series the crown of the first molar is fully formed and calcification has advanced in the incisors and canines, but their crowns are not complete.

At three years (fig. 6) the deciduous dentition is complete and fully erupted. Of the permanent teeth, the crowns of the first molars, the incisors and canines are fully formed and calcification

Two years.

Fig. 5.

has commenced in the first mandibular premolar, and is beginning in the corresponding maxillary tooth.

At four years calcification has commenced in the second premolars and in the second permanent molars.

At six years the permanent dentition is in the state shown in figs. 7 and 8. The crowns of the premolars are not yet fully formed but the calcification is nearer completion in the first premolar than in the second; the roots of the first permanent molars are also partially formed; the roots of the incisors have commenced to form; the crown of the canine is barely complete; the roots of the deciduous incisors show signs of absorption on the posterior aspects.

Three years.

Fig. 6.

Six years.

Fig. 7.

Attention is drawn to the position of the permanent teeth in relation to the deciduous teeth. In the maxilla, the permanent central and lateral incisors lie behind the corresponding deciduous teeth. The permanent teeth incline outwards to a greater degree than the deciduous teeth, and consequently the permanent teeth when erupted form a larger circle. The premolars are embraced by the roots of the deciduous molars and their crowns are directed inwards, the second a little more than the first. The canine above and external to the arch of the incisors and premolars is directed slightly outwards. The lateral incisor lies close to the premolar, and the first permanent molar, which is in the process of eruption,

Six years.

FIG. 8.

has the occluding surface directed outwards and backwards to a slight extent. The second permanent molar is situated high up in the tuberosity of the bone with the occluding surface directed downwards, outwards and well backwards.

In the mandible the lateral incisors are in a plane posterior to the centrals, and the canines are placed near the lower border of the bone and lie in a plane anterior to the lateral incisors with a slight tilt towards the median line. The premolars are embraced by the roots of the deciduous molars and their crowns are directed inwards. The first permanent molars are directed upwards and

forwards, and the second molar is under the base of the coronoid process with the occluding surface directed upwards, forwards and slightly inwards.

Fig. 9 shows the normal occlusion of the deciduous molars. The mandibular first molar is covered in its posterior two-thirds by the corresponding upper tooth and the second mandibular molar is covered in its anterior third by the maxillary first molar and in its posterior two-thirds by the maxillary second molar. The posterior borders of the second molars are not flush, the bulb on the upper

FIG. 9.

tooth projecting beyond the lower. It is this bulb which limits the forward movement of the maxillary first permanent molar and brings about correct occlusion.

In the specimen shown in fig. 10, a child aged about *seven years*, the first permanent molars have erupted into correct occlusion. In this specimen the lower central incisors are partially erupted.

In the skull of a child *nine years* of age (fig. 11) the four central incisors, maxillary and mandibular, are in place and the roots are nearly completed. In the remaining teeth the condition is as shown below:—

Canines. About half of the root is formed. The lower canine is a little less advanced than the upper.

First premolars. About one-quarter of the root is formed.

Seven years.

Fig. 10.

Nine years.

Fig. 11.

Second premolars. The formation of the root has commenced.
First molars. Roots nearly complete.
Second molars. The formation of the roots has commenced.

Calcification of the maxillary third molar would seem to commence at about ten years of age, and of the mandibular third molar somewhat later.

At the age of twelve years the incisors and usually the premolars are fully formed; the root of the canine is nearing completion; the second molar has the roots about two-thirds formed, and the crown of the third molar is calcified.

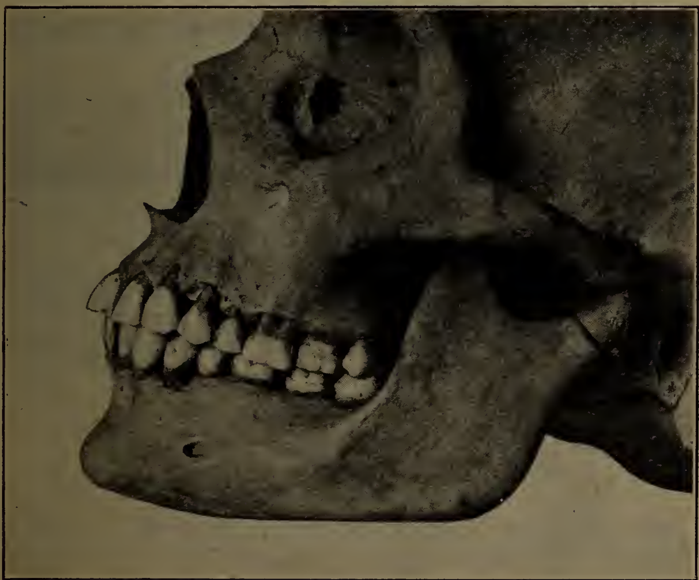


Fig. 12.

The formation of the second molars is complete about the sixteenth year, and of the third molars between the eighteenth and twentieth years. With the eruption of the third molars the second dentition is complete and should present the occlusion shown in fig. 12.

The specimens depicted above may be regarded as indicating approximately the normal amount of calcification at the periods specified, but there are wide variations from the normal as regards both development and calcification.

The diagrams shown in figs. 13 and 14 illustrate the amount of calcification of the deciduous and permanent teeth at various age periods.[1]

In the process of dentition the periods of greatest activity occur during the early years of childhood. This fact cannot be too strongly impressed upon parents by those responsible for the medical care of children.

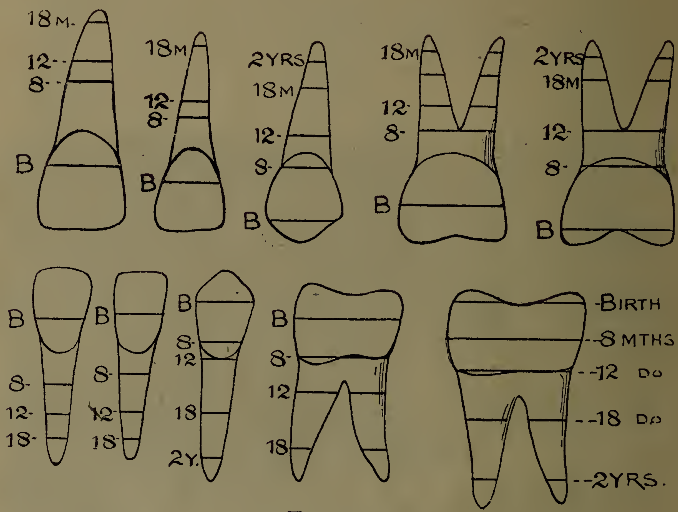


FIG. 13.[1]

(B) THE PROCESS OF ERUPTION[2]

A tooth lies deeply embedded in the tissues of the jaws during a considerable portion of its developmental period. As the time approaches for the performance of its natural functions, a movement to the surface commences and continues until the tooth emerges from the gum and assumes its position in the dental arch.

The precise manner in which the movement of the teeth in man is brought about presents a problem which has not yet been fully elucidated. But it seems probable that the mechanism which produces this movement in man is, in the main, identical physiologically with the mechanism which produces tooth movement in

[1] The material for the diagrams figs. 13 and 14 has been obtained from an examination of the skulls in the Odontological collection of the Royal College of Surgeons, and from Symington and Rankin's "Atlas of Skiagrams."

[2] For this section I am indebted to Mr. J. Thornton Carter.

the lower orders of animals, and that by studying the process of eruption in the lower animals information will be obtained which will enable us to interpret the process in man.

A tooth is essentially a dermal appendage and any attachment which it may obtain with adjacent bony structures must be regarded

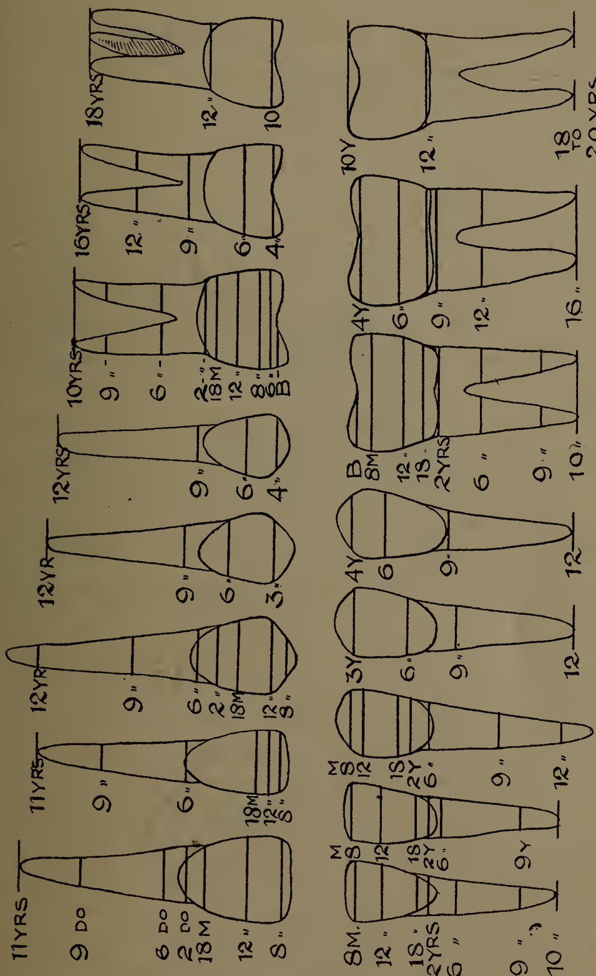


Fig. 14.

as purely adventitious. The complex conditions attending the prolonged developmental stage of mammalian dentition are a necessary provision for the protection of teeth during the period of their formation.

When an organ in any sensate creature moves from the position

in which it was situated during its development and occupies a fresh position suitable for the performance of its natural functions, the physiological movement is always attributable to growth. But what is it that grows and causes the tooth to erupt? Is the movement due to the growth of the tooth itself, or to growth in the soft tissues constituting the tooth follicle, or to growth in the bony tissues surrounding the tooth?

If an attempt is made to find an answer to these questions by studying the jaws of mammalians only, great difficulties present themselves owing to the complex nature of the growth of the jaws and the consequent obscurity of the operation, which are the natural accompaniments of the specialization of the parts and of the organs connected with those parts.

For the purpose of studying tooth movement the teeth of fishes probably present the least difficulty. In most fishes teeth are produced in an endless succession of series. Each series has only a short functional existence and is replaced by rapidly developed successors. The mechanism of eruption is here constantly in operation unobscured.

Take, for example, the case of the dogfish. In the dogfish, as in all cartilaginous fish, the teeth are attached to the fibrous mucous membranes which cover the maxillary and mandibular cartilages and are not implanted in alveolar cavities, nor are they confluent with the substance of the jaws even where the external crust is ossified. The numerous teeth, in successive series, are constantly moving slowly upwards and over the border of the jaw. When each series reaches the outer margin of the jaw it is cast off, while new teeth, in equal proportion to those lost, are being developed in the mesoblastic tissues deep in the jaw. This regular upward procession of the teeth is plainly observable, and it only remains to ascertain precisely in what manner the movement is brought about.

It is clear that there must be a change in the position of the fibrous membrane to which the denticles are attached corresponding to the tooth movement, and, on examining the osteo-cartilaginous jaws, the fibres of the sliding membrane and the bases of the successional tooth germs, it will be seen that this change of position is due to absorption and deposition of bone at the margin of the jaw operating on the membrane.

The amount of ossification in and about the jaws of cartilaginous fishes is very slight, and extends a very little way into the cartilage. At the margin of the jaw, however, at or about that part where the bases of the erupted functional teeth rest on the jaw, there is a considerable thickening of osseous tissue which forms a crust of

coarse and rapidly developed bone interspersed among the deeper fibres of the sliding membrane (fig. 15). This crust of bone—which is of a transitory nature, being constantly absorbed and deposited—is instrumental in causing the progressive movement of the sliding membrane. It is only at this part of the jaw that there is any intimate attachment of the sliding membrane to the tissues lying beneath, as may easily be observed by stripping the tooth-bearing membrane from the jaws.

The ossification at the margin of the jaw—which gives stability to the teeth during their short functional life, and protects the margin of the cartilage and the rapidly proliferating cells of its surface—affords the first phylogenetic evidence of an alveolar process in higher vertebrates.

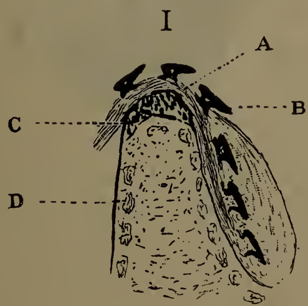


FIG. 15.—Section through jaw of dogfish. A, sliding membrane; B, tooth; C, bony crust; D, cartilaginous jaw.

When a functional tooth is shed, absorption of the underlying bone takes place and also absorption of the fibrous membrane at its outcrop. As a natural sequence to the absorption of the underlying bone and fibrous membrane, there is a rapid proliferation of cells at the margin of the cartilage, with formation of bony tissue over the same area. The newly-formed bony tissue operates on the fibres of the sliding membrane—which is poor in cellular elements and ill-adapted for active growth—and causes the membrane to move upwards and bear with it the next successional tooth. Concomitantly, there is renewed proliferation of the epithelial cells at the base of the tooth-band to give origin to the enamel organ of a new member for the series.

This comparatively unobscured process of eruption in the dogfish probably furnishes us with the key to the process by which teeth are erupted in man. Throughout the animal kingdom connection of the teeth with the deeper fibres of the muco-periosteum of the

gums seems to be an essential factor in the process of eruption. As teeth become more specialized and less numerous and require a longer formative period during which the creature uses its jaws

FIG. 16.—Diagram of jaw, showing septa between the individual teeth. The base of the dentine papilla is continuous with the oral muco-periosteum. A, muco-periosteum of jaw; B, tooth; C, bone of jaw.

to some extent, the growth of the alveolar plates produces a groove, and transverse septa form crypts, in order to provide the necessary protection. These changes necessitate an upward prolongation from

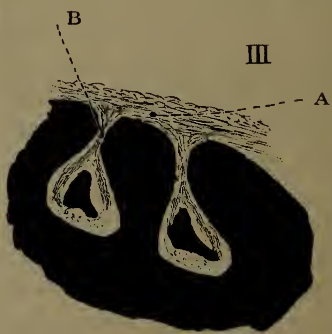


FIG. 17.—Diagram of jaw with teeth developed in bony crypts. The base of the dentine papilla is continued upwards around the tooth and communicates with the oral muco-periosteum by means of the "gubernaculum." A, muco-periosteum of jaw; B, gubernaculum.

the base of the dentine papilla to form a sac of connective tissue continuous with the deeper layers of the oral muco-periosteum (fig. 16).

Wherever a tooth is developed in a bony crypt below the surface of the jaw, a foramen will invariably be found leading from the tooth-bearing surface to the crypt, and transmitting a bundle of fibrous tissue continuous on the one side with the fibres of the periosteum, and on the other with those of the tooth sac (fig. 17). This bundle of fibrous tissue is known as the *gubernaculum*, but it must be clearly understood that its fibres exercise no traction in themselves and are merely sessile. The function of the gubernaculum is to afford a connection between the developing tooth and the membrane of the gums.

In fibrous tissues poor in cellular elements (the tooth sac and gubernaculum are composed of such tissues), there is little adaptation for active and rapid growth. When, therefore, in the parts surrounding the tooth sac there is great activity owing to cellular proliferation, the passive tooth organs, which are supported by fibrous tissues, necessarily undergo a change of position, the direction and extent of the movement of the tooth sac being dependent on the degee of growth in the surrounding parts.

Thus we may conclude that in man, apart from actual growth of the tooth itself, the cause of eruption, or at least an active factor in producing eruption, is to be found in the disproportionate growth occurring in the tissues forming the tooth and the tissues surrounding the tooth.

The rapid growth of the osseous tissues surrounding the tooth carries upwards the more slowly growing fibrous connective tissues composing the tooth sac, so that as regards the movement of the teeth these fibrous connective tissues perform the same function as the sliding membrane in the dogfish.

A tissue or organ continues to grow up to the limit afforded by the resistance of the neighbouring tissues or organs. The lessening of this resistance through absorption causes a resumption of growth and cell-division, and these processes are continued until the normal equilibrium is re-established. The use of the term "resistance" must not be taken in its literal mechanical sense. Growth, with its associated phenomena, leads to compensatory changes in the neighbouring tissues; these changes are not a direct mechanical effect of its disturbance, but a highly complex physiological response to it.

In order that the tooth may emerge the tissues overlying the crown must be removed. The manner in which this is effected was first described by Wilson and Hill in their classical memoir on "The Development and Succession of Teeth in Perameles."[1] They

[1] *Quart. Journ. Micros. Science,* 1897.

state " The process of eruption is very clearly seen to be attended by the flattening out of the enamel epithelium covering the tooth crown and its conversion into squamous epithelium with concomitant formation in it of epithelial ' nests ' or ' pearls ' close to the tooth cusps. This nest formation also proceeds in the oral epithelium over the tooth. Eventually the epithelial pearls become placed quite near the surface and they then undergo rupture and disintegration, their cores of epithelial cells being lost and the tooth crown exposed."

W. W. James has also described this phase of tooth eruption in Primates.[1]

In the hake this process of opening a track for the eruption of the tooth is delightfully simple. When the enamel cap is fully calcified, the process of eruption proceeds rapidly and is accompanied by certain marked changes in the enamel cells whose function has now been accomplished. An ingrowth of the cytoplasm of certain cells of the external epithelium takes place, and this ingrowth, inserting itself between the ameloblasts, divides them into groups or nests, frequently with no definite arrangement, but often causing them to become arranged in a series of loops. This invasion is most marked along a line corresponding to the area where the enamel cap will emerge in eruption.

When the apex of the crown is to be the point first to emerge, the cells of the external epithelium insert themselves between the bases of the ameloblasts over the whole vertex of the enamel organ and form a deep furrow. Sometimes there are two furrows running almost parallel and the ameloblasts lying beneath become changed, so that their nuclei stain with difficulty and their cytoplasm disappears in a sort of coarse vacuolation. The apex of the crown, however, is not invariably the point first to emerge from its investing epithelium, and when the tooth is going to erupt sideways the cells of the external epithelium traverse a small sector opposite which the rarefaction of the ameloblasts proceeds and permits the exit of the teeth.

Associated with these regressive changes there is an ingrowth of the oral epithelium which, on reaching the enamel organ, appears to extend about it for some distance, inserting itself between the enamel cells and the surrounding connective tissues; this epithelial ingrowth often extends down to the limits of the cells responsible

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[1] *Proc. Roy. Soc. Medicine*, 1909.

for the enamel cap, and at first consists of a narrow band of cells, two or three deep, but rapidly increases in size until it forms a large epithelial mass in contact at one end with the enamel organ and at the other end continuous with the cells of the oral mucous membrane. Cytolysis takes place in the centrally lying cells forming a way along which the tooth proceeds to erupt.

In venomous snakes, the ingrowth of epithelium to afford a path for the eruption of the tooth also serves to bring the poison fang into relation with the ducts of the poison gland. In the Australian Black Snake (*Pseudechis*) a duct passes from the gland—the modified parotid—forward along the side of the upper jaw and opens into a pocket lying just anterior to the bases of the poison fangs. This pocket is formed by a proliferation of epithelial cells which anteriorly extends downwards into the connective tissues in a crescentic form and into which the poison ducts open on its anterior surface. From the posterior margin of this crescentic ingrowth a band of epithelial cells passes backwards which eventually bifurcates, sending down a separate ingrowth to the developing poison fangs which lie parallel in a double series. This epithelial ingrowth is quite distinct from the true tooth band. When a functional tooth is shed its successor proceeds along this epithelial track and moves forward until it reaches the pocket, where it becomes anchylosed by its base to the maxilla with the groove on its anterior surface in contact with the opening of the duct of the poison gland. In this manner an alternating succession of poison fangs is provided similar to that of the vipers.

(C) THE ERUPTION OF THE DECIDUOUS TEETH

The normal signs of approaching eruption are an increased flow of saliva and an inclination on the part of the child to bite at any tangible object. A healthy child will often cut its teeth without the slightest trouble, but more often the gums are a little tumid, tense, and shining over the erupting tooth, the local condition being accompanied by slight irritability, restlessness, and a rise of temperature.

The order and date of eruption vary considerably within normal limits. For example, A. T. Spanton (*British Medical Journal*, June 3, 1907, p. 1362) examined 200 healthy breast-fed children of normal parents to ascertain which tooth of the deciduous set was the first to appear. The summary of his investigations is given below:—

TABLE SHOWING THE TOOTH WHICH WAS THE FIRST TO APPEAR THROUGH THE GUM IN THE CASE OF 100 BOYS AND 100 GIRLS.

First tooth or teeth to appear through the gum	(a) 100 Boys alone	(b) 100 Girls alone
Right lower central incisor	39	32
Left lower central incisor...	32	39
Both lower central incisors together	14	15
Right upper central incisor	10	2
Both upper central incisors together	5	6
Left upper central incisor	0	6

The average age when the first tooth erupted was, boys 252 days, girls 221 days.

These figures tend to show that, on the average, girls begin to teeth thirty-one days earlier than boys.

Reliable statistics as to the order and time of eruption of the deciduous teeth are not available, but the following dates may be taken as approximately correct:—

Mandibular central incisors, fifth to eighth month.

Maxillary central and lateral incisors, seventh to tenth month.

Mandibular lateral incisor, tenth to twelfth month.

First molars, twelfth to fourteenth month.

Canines, fourteenth to twentieth month.

Second molars, twentieth to thirtieth month.

As a rule the teeth erupt in pairs or groups, and between the eruption of each group there is an interval which varies from two to five months, the interval becoming greater between the later groups.

Eruption of teeth before birth is extremely rare. When this occurs the teeth are usually imperfectly developed and loosely attached to the muco-periosteum, but occasionally they are well formed and attached to normal alveoli.

(D) THE ABSORPTION OF THE DECIDUOUS TEETH

The removal of the deciduous teeth is brought about by the action of multi-nucleated cells possessing an osteoclastic function. In this way the root is gradually removed and the crown remains as a hollow shell over the position of the erupting permanent tooth. Intervening between the deciduous and the permanent tooth is a

soft vascular substance which has received the name of the "absorbent organ."

If a microscopical section is made of a deciduous tooth with the absorbent organ in position, it will be seen that the soft vascular part is composed of a mass of cells, those nearest to the dentine being multi-nucleated and fitting into the cup-shaped excavations in the dentine. Fig. 18 is a drawing of the absorbent cells in contact with the dentine. It will thus be seen that the so-called absorbent organ is only a mass of cells, some of which act as osteoclasts. In absorption of the permanent teeth, a typical example is the pressure of the mandibular third molar upon the posterior root of the second mandibular molar. A section through the absorbed portion will show exactly the same condition as may be observed in an absorbed deciduous tooth.

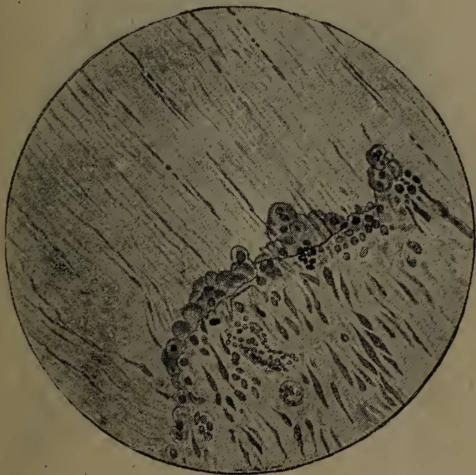

Fig. 18.[1]

In specimens of rarefying periodontitis, Howship's lacunæ filled with the characteristic giant cells can be seen. The disappearance of the tooth tissue of the deciduous tooth undoubtedly depends upon the presence of these multi-nucleated or osteoclastic cells, but it is not clear how they perform their work. Some writers suggest that the cells send out amœbiform processes, others that they secrete an acid which dissolves the tooth substance, the remaining organic substance being removed by phagocytic action. What determines the presence of the so-called absorbent organ is as yet unknown.

[1] From a drawing by J. Howard Mummery.

Whether it is due to the presence of and pressure from the permament teeth, or to some other agency, is a problem which still awaits solution. When deciduous teeth contain septic pulps the process of absorption seems to take place slowly and in some instances not at all.

Changes in the Pulp of Deciduous Teeth undergoing Absorption.—An examination of a deciduous tooth which is in the process of absorption will show that the large nerve trunks have

Fig. 19.

been destroyed and that the pulp is fibrous and vacuolated. It will also be seen that at the terminal margin of the pulp there is a well-marked layer of fibrous tissue (see fig. 19).

(E) THE ERUPTION OF THE PERMANENT TEETH

With the permanent teeth, as with their predecessors, there appears to be no fixed rule either for the order or for the time of eruption.

S. Cartwright published[1] a detailed account of over 3,000 cases which he had examined, and a perusal of the figures recorded clearly indicates not only that there is a considerable variation in the ages at which the various teeth erupt, but also that the order of eruption varies. An examination of about 7,000 persons was made by Dietlin,[2] and his records show similar variations.

C. Röse has compiled statistics comprising particulars of over 40,000 children of both sexes.[3] His conclusions are:—

(*a*) That the time of eruption varies widely, the limits of variation being smallest in the first permanent molars and largest in the canines and premolars.

(*b*) That in the female sex the teeth erupt on an average four and one-half months earlier than in the male sex. The difference is smallest in the eruption of the first permanent molars, and largest in the canines.

(*c*) That the time of eruption varies in the different races.

(*d*) That eruption occurs earlier in the children of the leisured classes than in the children of the working classes.

From clinical experience it would seem that the first permanent molars and the incisors erupt in somewhat rapid succession, and that their eruption is followed by a distinct period of rest often extending over two years. After this rest, another period of eruption occurs, and the premolars, canines and second molars appear. The approximate order and date of eruption of the permanent teeth are shown below.

Mandibular first molars Maxillary first molars Mandibular central incisors Maxillary central incisors Mandibular lateral incisors Maxillary lateral incisors	6 to 8 years.
Maxillary first premolars ...	10 to 11 years.
Mandibular first premolars Maxillary second premolars Mandibular canines	11 to 12 years.
Mandibular second premolars Maxillary canines Mandibular second molars Maxillary second molars	12 to 13 years.
Third molars	20 to 25 years.

The time of eruption of the third molars depends, to a great extent, upon the amount of space in the arch. With all the

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[1] *British Journal of Dental Science*, May, 1857.

[2] *Oesterreich-Ungarische Vierteljahrsschrift für Zahnheilkunde.* (Translated in Ash's *Quarterly Circular*, Sept., 1895, p. 353, and Dec., 1895, p. 484.)

[3] *Deutsche Monatsschrift für Zahnheilkunde*, August, 1909.

teeth present the figures given in the above table probably represent the average age of appearance. The early removal of second molars will accelerate the appearance of the third molars which may erupt as early as the fifteenth year, and early removal of the first molars may produce the same effect.

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CHAPTER II

Pathological Dentition

Disorders associated with the Process of Teething—Retarded Eruption—Partial Eruption—Impeded Eruption—Pathological Changes in Teeth which have failed to Erupt

(A) DISORDERS ASSOCIATED WITH THE PROCESS OF TEETHING

(1) General

Certain general disorders frequently occur about the time of teething and considerable diversity of opinion exists as to the exact relationship between these disorders and the process of teething. Formerly illnesses at this period appear to have been readily regarded as a natural sequence to the process of dentition, whereas the tendency now seems to be in the opposite direction, and in searching for the cause of general disorders dentition is often ignored.[1]

In endeavouring to arrive at the actual facts of the case it is well to remember that weakly children, especially if they have been hand-fed, are prone to general disturbances, and that local trouble in the mouth probably tends to aggravate such conditions. Further, general disturbances occurring during teething are often wholly traceable to other causes; for example, gastro-intestinal troubles may be due to defective feeding, convulsions to a smilar cause, and respiratory affections and otitis media to the presence of adenoids. But after due allowance has been made for all known causes there still remain cases of general disturbance which are coincident with dentition, and which cannot be accounted for if they are not to be attributed to the dental condition. There is naturally extreme difficulty in placing dentition in causal relationship with such disorders, because we have to rely mainly on clinical observation; but

[1] In compiling this section I have been greatly assisted by G. F. Still's work on "Common Disorders and Diseases of Childhood," Third Edition.

it seems only reasonable to assume that such a relationship does exist when the occurrence of a disorder not only coincides with dentition but has a special tendency to coincide repeatedly with the eruption of successive teeth.

In referring to this question, Still expresses the opinion that there is too great a tendency to assume that because dentition is a physiological process it is incapable of causing disturbance of health. He points out that pregnancy is also a physiological process, and no one would deny that pregnancy may disturb the health in many ways. Still states that, with increasing experience, he is inclined to enlarge rather than to restrict his conception of the *rôle* which dentition plays in the production of disturbances of various kinds during infancy.

Clinical observation clearly establishes the fact that irritation often exists in the mouth during the period of eruption. In most cases the irritation is due to direct pressure of the tooth upon the superincumbent tissue. J. W. White points out that the aperture at the end of the growing tooth is large, and undue resistance of the gum tissue would lead to pressure on the nerve trunks entering the pulp. White supports his view by clinical evidence afforded by cases in which there are no local signs of inflammation and in which constitutional disturbance disappears when the gum is lanced.

The following general disorders may, in Still's opinion, *be traceable to dentition:*—

(*a*) Loss of appetite.

(*b*) Failure to gain weight or diminution in the ratio of gain. This condition is frequently associated with dentition and may be attributable to the tenderness of the gums. The weight is, however, made up in the intervals between the eruption of the different teeth.

(*c*) Sleeplessness.

(*d*) Instability of the nervous system. Infants troubled with coming teeth often show a tendency to convulsive twitchings, upward rolling of the eyes, slight strabismus, although not losing consciousness. In children of neuropathic heredity, or who, through rickets, are predisposed to infantile convulsions or epilepsy, dentition appears to be distinctly a time of peril. Still has seen attacks of *petit mal* which were much aggravated by dentition and ceased when the last tooth was cut.

(*e*) Rise of temperature. This may occur without the presence of an inflamed condition of the gums, and is probably in most cases purely reflex and analogous to cases in which neurotic children will show a rise of temperature with any excitement, such as a visit to

a pantomime; the rise of temperature with the worry of an erupting tooth is thus part of the induced instability of the nervous system.

(*f*) Attacks of vomiting sometimes occur, with little or no disturbance of the bowels, shortly before the appearance of a tooth.

(*g*) Bronchitis and diarrhœa. Although children are prone to these conditions, there are cases, nevertheless, which seem to be distinctly nervous and traceable to reflex influence from the teeth. That such a condition could exist is quite conceivable since the bronchial catarrh of the asthmatic child and the lienteric diarrhœa (the nervous diarrhœa of Trousseau) are admittedly dependent upon nervous influence, often quite remote from the organs affected.

(*h*) Violent screaming attacks, independent of any digestive disorder and not obviously due to any pain, are sometimes associated with dentition. This condition is, however, uncommon.

(*i*) Photophobia. This may be so pronounced "that the child will cover his eyes with his hands or bury his face in the pillow or against his mother's breast, when exposed even to the moderate light of a sunless day." The photophobia may be so extreme that the child cries or screams violently when exposed to ordinary daylight.

(*j*) Head retraction. Still has seen a condition in which meningitis has been simulated by head retraction. This condition is often present in cases of increased tension in the middle ear, but he remarks that there has been nothing to suggest this condition in the cases he has seen associated with dentition.

(*k*) A rare disorder which is closely related to dentition is *spasmus nutans*, or head-nodding with nystagmus. This disorder is so distinctly coincident with dentition in its onset and cessation, and is so definitely aggravated by the eruption of a fresh tooth, that there would seem to be a causal relationship between the two.

Treatment.—The treatment of these conditions lies within the province of the general practitioner, but the dental surgeon may be consulted with a view to lancing the gums. This operation, if considered necessary, should be performed as follows: "A curved bistoury should be used, and, in order to prevent injury to surrounding parts, a strip of lint should be wrapped round the knife so that only ½ in. is exposed. The technique of the operation is quite simple. The child should be placed on a pillow on the lap of the nurse, who should be seated on a chair opposite the operator, and with her back towards the source of light which should come preferably from a north window. The operator should seat himself facing the nurse, with the end of the pillow supporting the child's head in his lap. He thus commands the territory of operation,

and, by holding the child's head, can guard against any sudden movement. The hands and the body of the child must be firmly held by the assistant. The lancet is then passed through the overlying tissue until it is felt to come into contact with the enamel surface, and the tissue divided sufficiently to allow the tooth to erupt without resistance" (Kirk).

The best method is to make two semilunar incisions which meet at their extremities, and remove the intervening portion of gum with a pair of tenaculum forceps. Objection has been raised to the use of the lancet while the tooth is still considerably below the surface, on the ground that cicatricial tissue offers greater resistance to the progress of the tooth than fibrous tissue; but as cicatricial tissue is of a lower degree of organization than normal fibrous tissue and therefore more easily disintegrated by pressure, this objection is not tenable.

(2) Local

Simple Stomatitis.—The stomatitis is usually confined to the neighbourhood of the erupting tooth, and is characterized by intense redness and swelling, the mouth at the same time being hot, the child fractious, restless, and in evident pain. The temperature may reach 104° or 105° F.; but it should be remembered that pyrexia in children readily supervenes upon slight causes.

Ulcerative Stomatitis.—In these cases the gums become hot, swollen, and painful, and these symptoms are especially marked over a certain tooth. Ulceration supervenes, and may extend to the gum around any other tooth already erupted. The ulcers thus formed have a sloughy appearance; the breath is fœtid and hot; the flow of saliva is increased, and the child rejects its food. In addition, there is marked pyrexia and, at times, gastro-intestinal disturbance. Ulcerative stomatitis is due to local infection, and may often be traced to dirty feeding bottles or neglect of oral hygiene. It is interesting to note that the local disturbances associated with dentition decrease in proportion to the care exercised in dealing with oral hygiene.

Treatment.—Treatment of the local condition consists in paying strict attention to the hygiene of the mouth and the application to the gums of hydrogen peroxide; a brisk purge should also be given. In cases where the ulceration shows signs of spreading, the application of an escharotic is advisable. The patient should be isolated.

Superficial Cysts.—Small cysts occasionally form over erupting teeth, but they do not interfere with eruption. On being

punctured they give forth a small quantity of clear fluid. These cysts are lined with "epithelium many layers thick, spheroidal at the growing periphery, and tending to become stellate on the cyst side" (J. G. Turner). Occasionally, the cyst is of abnormal size, indeed, sufficiently large to attract the attention of parents. Under these conditions, puncturing does not, as a rule, bring relief, and it is necessary to remove the gum covering the tooth.

The local disturbances accompanying eruption of the permanent teeth are chiefly associated with the third molars, especially the mandibular. When a mandibular third molar erupts the anterior cusps appear first, and the small portion of gum which lies over the posterior part of the tooth occasionally ulcerates from constant pressure of the antagonizing tooth. The ulceration may become extremely painful and the adjacent tissues may become involved. The patient complains of pain in the region of the fauces, but perhaps the most tender point is where the mucous membrane of the gum becomes continuous with that of the cheek. This condition is best relieved by free incisions, care being taken that the knife divides all the tissues overlying the buccal surface of the tooth. Should this treatment not bring relief, it is advisable to remove the process of gum that is covering the tooth; this can be accomplished with the scalpel and forceps. In addition, fomentation of the inside of the mouth should be advised, and hot water at a temperature just bearable is perhaps as comforting an application as any, although decoction of poppy-heads is often to be recommended, the opium contained in the poppies acting as a local anodyne. The ulcerated surface should be frequently swabbed with hydrogen peroxide. Suppuration may supervene, and in that case the offending tooth must be removed, otherwise trismus may occur. The trismus is said to be produced in most instances by spasm of the masseter muscle, due to reflex irritation; but it is more than probable that the trismus is generally caused by spread of inflammation to adjacent tissues. The insertion of the temporal and pterygoid muscles and the intervening cellular tissue may, by a process of continuity of inflammation, become affected, and produce closure of the jaws. The latter explanation of the occurrence of the trismus also seems to be more in harmony with the clinical aspect of the majority of cases met with, for, in nearly all of them, the patient is able to effect slight movement in the articulation, which would not be possible if the trismus were due to tonic spasm of the masseter muscle. Moreover, the mobility of the articulation increases as the inflammatory symptoms subside. It appears probable, therefore, that in most cases of trismus the condition is

to be attributed to the inflammatory process, but no doubt instances may occur where the closure of the jaw is due to a tonic spasm of the muscles of mastication. The treatment of the above condition is to remove the erupting tooth.

Mandibular third molars, when impacted, may give rise to severe odontalgia in the second molar, the pressure from the erupting tooth causing absorption of the posterior surface of the second molar, leading to exposure of its pulp. The absorption in these cases is not due to the pressure of the crown of the third molar against the cementum or enamel of the second, but to multi-nucleated cells which are developed at the point of contact, and which perform the function of osteoclasts in removing the obstructing tissues. In these cases the second molar should be removed. For further reference to misplaced third molars see chapter V.

(B) RETARDED ERUPTION

Rachitis.—In children suffering from rickets, the eruption of the teeth is sometimes considerably retarded, and it is not uncommon for the advent of dentition to be delayed until the commencement of the second year. Retarded eruption of the permanent teeth is also met with in those who have suffered from rickets in infancy. A case of this character is shown in figs. 20 to 23. The patient was a female, aged 14, and had been the subject of prolonged rickets in infancy. The retarded eruption in rickets is attributed by some observers to thickening of the tooth sac. The fact that fibrous odontomes are formed in rickety animals supports this view (see chapter XXII).

The specimen shown in fig. 24 would seem to throw some light on the subject. The animal, a cat which died at the age of three years, had suffered from pronounced rickets. The only teeth present in the mouth at the time of death were an incisor in the maxilla and an incisor in the mandible; the cusps of a premolar and a molar in the maxilla and a molar in the mandible had also appeared.

Considerable difficulty was experienced in removing the outer alveolar plate to expose the teeth. The bone bordering the oral cavity was of a hard, compact nature, and the premolars instead of resting in crypts were found to be welded, as it were, to the bone, the latter being quite ivory-like in character. The maxillary canine rested in a crypt the walls of which were of a hard, compact nature.

Syphilis.—The general effect of syphilis on eruption is to delay

Fig. 20.—Model of maxillary teeth. The only teeth of the permanent series erupted are the first molars. A conical-shaped supernumerary tooth is present between the deciduous central incisors.

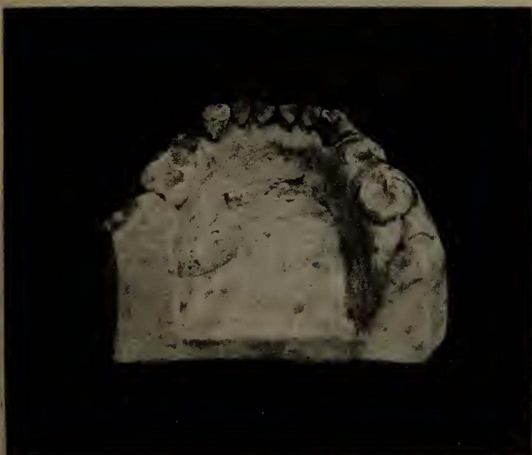

Fig. 21.—Model of mandibular teeth. The only teeth of the permanent series present are the first molars.

Fig. 22.—Skiagram showing the unerupted mandibular incisors.

Fig. 23.—Skiagram showing the unerupted mandibular premolars.

Fig. 24.[1]

[1] From *Trans. Odonto. Soc.*

the process, but in a few instances syphilis may accelerate eruption.[1] (For further details of the effect of syphilis on dentition see p. 85.)

Idiocy.—The teeth of micro-cephalics and cretins are usually small, and eruption is considerably delayed. In cretins the eruption of both the deciduous and permanent dentition is often delayed and may also commence irregularly, though in the subsequent growth of the permanent series the trend is towards eventual perfection of the dentition.

It is interesting to note that the administration of thyroid extract, which assists growth in general, also promotes the eruption of the teeth. In cases where no general improvement follows the administration of thyroid, there is no effect on dentition.[2]

Retardation in the Eruption of Individual Teeth.—Occasionally it is found that dentition has occurred normally with the exception of individual teeth which appear only after a considerable interval.

In the maxilla the eruption of the canine may be delayed until the twentieth to twenty-fifth year. Cases occur in which the canine teeth do not appear until quite late in life. Retarded eruption of the canines is much more common in the female than in the male, and is met with in the well-to-do more frequently than in the less favoured classes. The premolars are, at times, retarded in their eruption. In one patient under observation the second right maxillary premolar did not appear until the age of 35. The third permanent molar is frequently retarded and may erupt at any time.

In the mandible the first and second premolars are frequently retarded in their eruption, and the appearance of these teeth may be delayed for two or three years. The second premolar is more frequently retarded in its eruption than the first. The mandibular third molar may erupt at any time after puberty. In one case under observation the right mandibular lateral incisor did not appear until the fourteenth year.

When a tooth appears late in life the process must be looked upon not as an eruption but as an uncovering of the tooth through atrophy of the superincumbent tissues.

(C) PARTIAL ERUPTION

In the deciduous series, a partial eruption of the molars is occasionally seen and is not infrequently associated with a history

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[1] See article by Dr. Cavallaro on "Syphilis in its Relation to Dentition," *Cosmos*, November, 1908, to February, 1909.

[2] "Teeth of Micro-cephalics and Cretins," by J. G. Turner, *Trans. Odonto. Soc.*, vol. xxxiv, p. 1.

of rachitis. Under these conditions, the molars occlude, but the upper incisors may overlap the lower teeth and impinge on the gum. With the eruption of the first permanent molars, the "bite" becomes more open and a space is formed between the deciduous molars as seen in figs. 25 and 26.

FIG. 25.[1]

This partial eruption of the deciduous molars may be limited to the first molars, so that with the eruption of the second molars a space will exist between the first molars.

FIG. 26.[1]

In the permanent dentition partial eruption of the premolars or of the molars may occur, and in such cases there is frequently a

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[1] From *Proc. Roy. Soc. Med.*

history of retarded eruption. In fig. 27 is shown a case where the right first mandibular molar was partially erupted.

An instructive case of arrested eruption of teeth has been recorded by A. T. Pitts.[1] A male, twenty-three years of age, pre-

Fig. 27.

sented the following condition: on the left side of the mandible the first premolar was missing, and the second premolar, together with the first and second molars, were retarded in their eruption, the

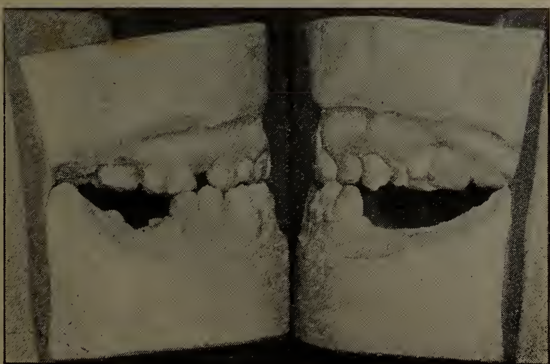

Fig. 28.[2]

crowns of the teeth alone being exposed; on the right side the first molar in the mandible was carious, but sufficient of the crown

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[1] *Proc. Roy. Soc. Med.* (Odonto Sec.), vol. v, p. 147.
[2] From *Proc. Roy. Soc. Med.*

remained to show that it was only imperfectly erupted, while the maxillary second molar was partly erupted (see fig. 28).

The skiagram of the mandible (fig. 29) showed that the partly erupted teeth were fully formed, but that the body of the bone in this region was insufficiently developed. This case would seem to suggest that the eruption of the teeth is closely associated with the growth of the body of the bone, and that when growth is insufficient neither the formation of the root nor the development of the bone around the teeth suffices to bring about the eruption of the teeth.

Teeth which are partly erupted are liable to become the seat of chronic sepsis. In the fully erupted tooth the "gingival trough"[1]

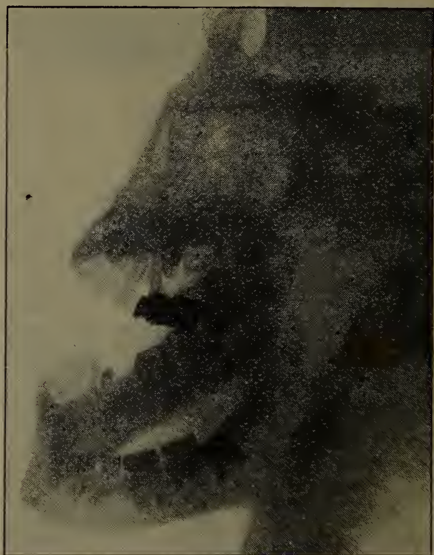

Fig. 29.[2]

is shallow, in the partially erupted tooth it is deep (see diagram, fig. 30).

In the deep trough septic matter is liable to accumulate and

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[1] The furrow around the tooth formed by the fold of gum has been named by Hopewell-Smith the "gingival trough." This term will be used throughout the following pages.

[2] From *Proc. Roy. Soc. Med.*

cause injury to the periodontal membrane, which may lead to changes in the hard tissues as shown in the case illustrated in fig. 31.

(D) IMPEDED ERUPTION

This condition may arise in a variety of ways. Premature loss of a deciduous tooth may be the indirect cause of impeded eruption of its successor owing to the tilting together of the adjacent teeth.

Fig. 30.—The "gingival trough" in the fully erupted tooth is shown on the right side, that of the partially erupted tooth on the left side.

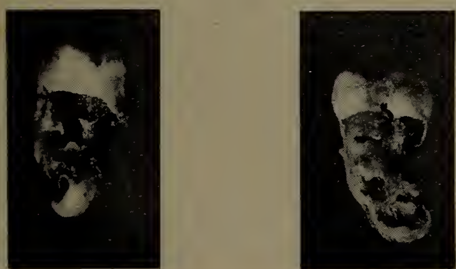

Fig. 31.—Mandibular left second molar showing extensive destruction of the root. From a paper by A. Hopewell-Smith. *Proc. Roy. Soc. Med.* (Odonto. Sec.), vol. iii, p. 9.

The obstructing agent may be a supernumerary tooth, or may be a persistent deciduous tooth which has become wedged in consequence of the approximal teeth having inclined towards each other. Geminated deciduous teeth may act as impediments, and a case has been seen in which the mandibular central incisor was prevented from erupting because absorption had taken place only at that part of the root corresponding to the deciduous central incisor, leaving

the portion of the root corresponding to the lateral incisor firmly embedded and unabsorbed.

(E) PATHOLOGICAL CHANGES IN TEETH WHICH HAVE FAILED TO ERUPT

Teeth which have failed to erupt often show pathological changes in their structure. The changes consist in an absorption of the dentine and a replacement of the lost dentine by tissue of an osseous character. A case illustrating these changes is described by Williger.[1] A maxillary unerupted canine was removed, and, on

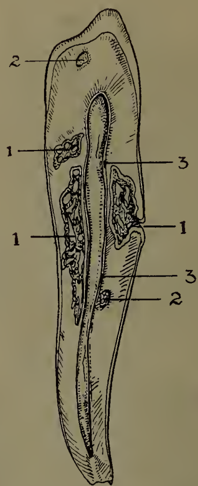

Fig. 32.[2]—1, absorption areas well marked; 2, absorption areas commencing; 3, secondary dentine.

section, spots were visible as if the dentine were perforated (fig. 32). Microscopical examination showed that the dentine had been absorbed and in great measure replaced by osseous tissue (fig. 33). The absorption was due to a growth of tissue from the periodontal membrane and not from the pulp. The presence of secondary dentine on the walls of the pulp canal showed that the pulp had reacted in the same manner as in other injuries of the dentine.[3]

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[1] Translated in Ash's *Quarterly Circular,* January, 1909, from the *Correspondenz-Blatt für Zahnheilkunde.*

[2] By permission from Ash's *Quarterly Circular.*

[3] In connection with this subject, see papers by A. Hopewell-Smith, *Proc. Roy. Soc. Med.* (Odonto. Sec.), vol. iii, p. 9; and by J. F. Colyer, *Trans. Odonto. Soc.*, vol. xxv., p. 66.

An interesting case is recorded by A. W. Baker[1] of an unerupted mandibular third molar which showed definite changes. A sinus led to the tooth, and it is probable therefore that there had been a

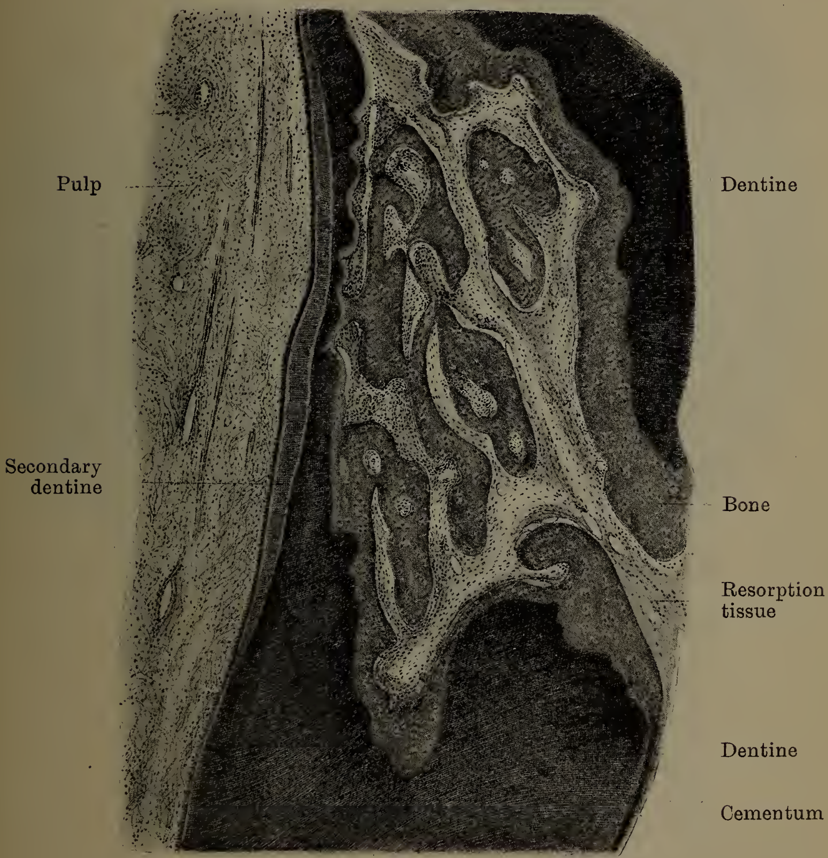

FIG. 33.[2]

septic infection of the tooth crypt. The tooth showed considerable hyperplasia of the cementum, a thick layer of this tissue being deposited external to the enamel and the original cementum as

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[1] *Proc. Roy. Soc. Med.* (Odonto. Sec.), vol. i, p. 130.
[2] Copied by permission from Ash's *Quarterly Circular*.

shown in fig. 34. At one part of the root the original tissue had been removed and in places replaced by compact bone (fig. 35).

In Williger's case quoted above there is no mention of the presence of sepsis, but in the cases which have come under my

FIG. 34.[1]—Longitudinal section. × 50.

personal observation septic infection has always been present, and the changes which occur in misplaced teeth are probably the result of long-continued sepsis of mild intensity.

[1] From *Proc. Roy. Soc. Med.*

FIG. 35.[1]—Transverse section. × 60.

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[1] From *Proc. Roy. Soc. Med.*

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CHAPTER III

Variations of the Teeth

Variations in Size—Variations in Number—Variations in Shape—Anomalous Teeth

(A) VARIATIONS IN SIZE

There is considerable variation in the general proportions of series of teeth. See fig. 36.

As a general rule the teeth comprising a series bear a definite relation in size to one another. Occasionally, however, this relation

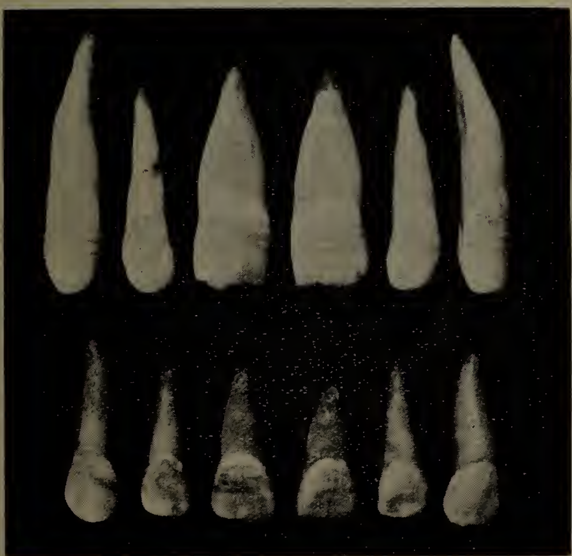

Fig. 36.

is disturbed, and one or more teeth will be found to be disproportionately large or small in comparison with the remainder of the series.

(1) Permanent Dentition.—In the permanent series, the tooth which is most frequently developed to an *abnormally large* size is the maxillary central incisor. Such teeth should not be mistaken

for a central incisor geminated with a supernumerary incisor. The second mandibular premolar and the second mandibular molar are, occasionally, abnormally large. *Diminution in size* occurs mostly with the lateral incisors. These teeth may also be modified in their shape, and, in extreme cases, are represented by simple cones. The maxillary third molar, like the lateral incisor, is often dwarfed and modified in shape.

(2) Deciduous Dentition.—The maxillary canine or mandibular molar may be proportionately larger than the other teeth. Such teeth have no particular interest unless they persist, in which case it is sometimes difficult to distinguish them from the permanent teeth. If, however, care is taken in the examination of the mouth, and the history of former extractions is ascertained, no error is likely to arise. A deciduous canine can generally be distinguished from a permanent one by:—

(*a*) The abrupt termination of the enamel at its neck.

(*b*) The signs of attrition of the cutting edge.

(*c*) The size—it is proportionately smaller than the permanent tooth.

(*d*) The enamel, which is usually translucent.

A second mandibular deciduous molar may be distinguished from a permanent one by:—

(*a*) The abrupt termination of the enamel at its neck.

(*b*) The absence of the second premolar.

It will, also, be generally found wedged between the first premolar and the first permanent molar, and on a lower level than those teeth.

(B) VARIATIONS IN NUMBER.

(1) Permanent Dentition.

In the permanent series the number of teeth may be greater or less than the normal number.

(1) Excess in Number.—Any tooth in excess of the normal number is known as a supernumerary tooth. Supernumerary teeth are divisible into two groups, viz.:—

(i) Resembling normal teeth in shape or character.

(ii) Abnormal in form.

(i) In this group the supernumerary tooth usually resembles a lateral incisor, less frequently a premolar, or a molar, and, in very exceptional cases, a canine. As a rule, these teeth are found in the neighbourhood of the tooth simulated. In the great majority of cases they occur in the maxillary lateral incisor region, but an

extra incisor or incisors in the mandible is by no means rare. In the maxillary incisor region they are generally either larger or smaller than those in the normal position; the condition is often

Fig. 37.—Model showing two supernumerary incisors.

symmetrical (fig. 37). A model showing a supernumerary incisor with the central incisor geminated with another tooth is shown in fig. 38.

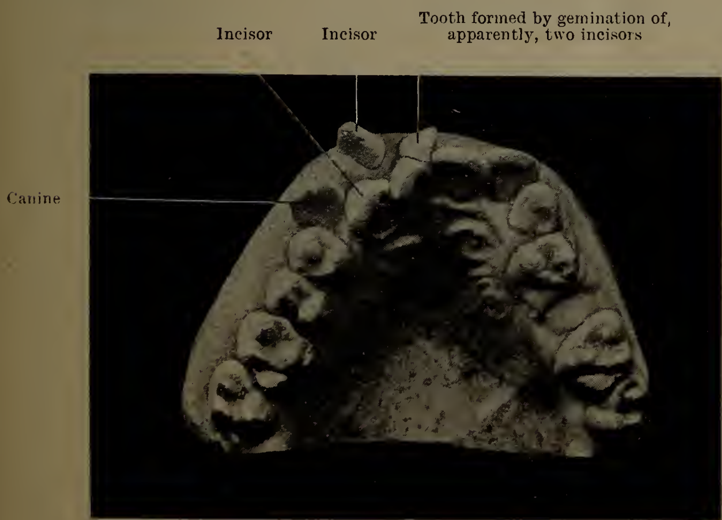

Fig. 38.—A model showing a supernumerary incisor with the central incisor geminated with another tooth.

An extra incisor is often associated with cases of cleft palate, the extra tooth being situated on the mesial side of the cleft. The usual arrangement of the teeth in cleft palate cases is, starting from the median line, central incisor, cleft, badly formed tooth, canine.

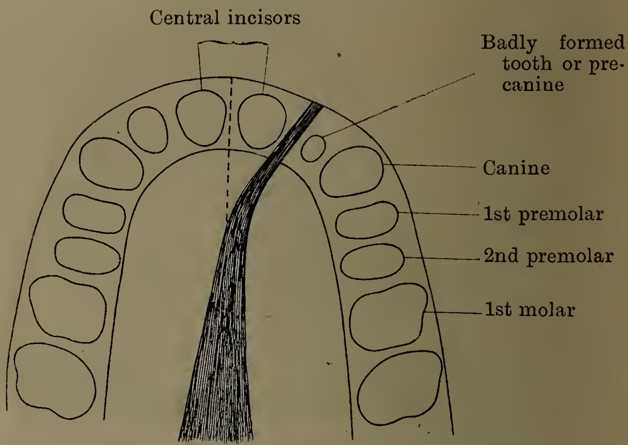

Fig. 39.—Usual arrangement.

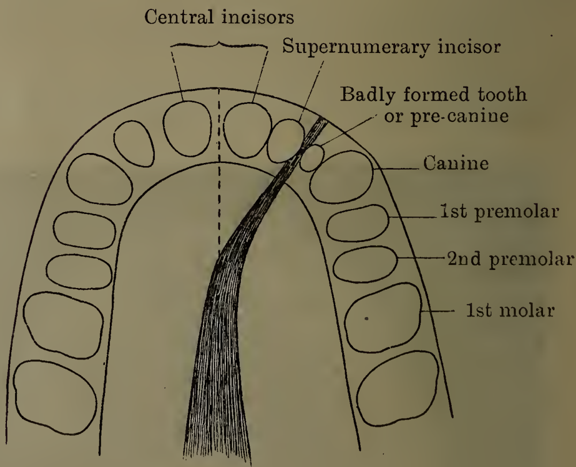

Fig. 40.—Unusual arrangement.

The badly formed tooth is always situated in front of the canine, and has been termed the "pre-canine." It is the representative of an incisor. When a third tooth is present it is often well formed, and situated on the mesial side of the cleft (see figs. 39, 40, 41).

The relation of the "pre-canine" to the suture is shown on skiagram reproduced in fig. 42.

Extra premolars are met with both in the mandible and in the

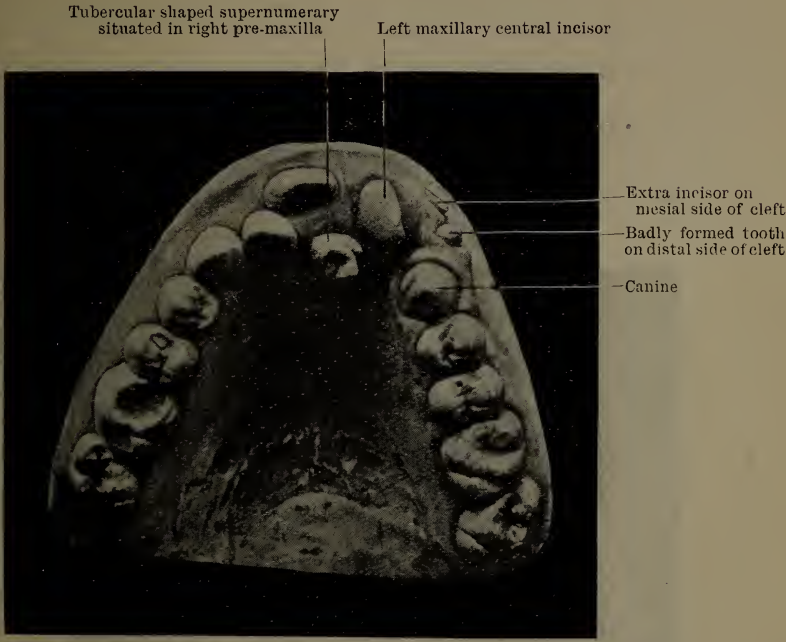

FIG. 41.

FIG. 42.

maxilla, an extra tooth often appearing on both sides. In a remarkable case (fig. 43) which occurred in the practice of C. Handley, there were no less than six premolar teeth on one side, in addition

to two other supernumerary teeth. Blair[1] gives an illustration of a case of an unusual number of teeth in the right maxilla of a boy fifteen years of age. It is a little difficult to determine the nature of the teeth from the illustration, but they appear to be four premolars and four deciduous molars. A model showing five mandibular premolars on one side was exhibited by P. Linnell at the annual meeting the British Dental Association held in Manchester in 1892.

In the molar region the additional tooth is generally found in the region of the third molar, and generally erupts external to the arch. The additional tooth is usually diminutive in size, and it is

Fig. 43.

by no means uncommon to find the third molar also dwarfed in character.

Fig. 44. This case was reported in the *Dental Cosmos*, December, 1891. The patient was a man aged 41; the supernumerary teeth had erupted at the age of 35.

Supernumerary molars in the mandible are rare.

A unique case of supernumerary teeth is recorded by Cope.[2]

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1 "Surgery and Diseases of the Mouth and Jaws," Third Edition, p. 434.

2 *Journ. Brit. Dent. Assoc.*, vol. vii, p. 254.

The following was the dental formula:—

$$\text{i. } \tfrac{5}{4}, \text{ c. } \tfrac{1}{2}, \text{ pm. } \tfrac{3}{0}, \text{ m. } \tfrac{3}{3}\ \tfrac{3}{4}.$$

The first two molars were furnished with accessory lobes. A brother of this patient had—

$$\text{i. } \tfrac{4}{4}, \text{ c. } \tfrac{1}{1}, \text{ pm. } \tfrac{2}{1}, \text{ m. } \tfrac{3}{3},$$

and a sister—

$$\text{i. } \tfrac{3}{3}, \text{ c. } \tfrac{1}{1}, \text{ pm. } \tfrac{2}{1}, \tfrac{2}{2}, \text{ m. } \tfrac{3}{3}.$$

a grandmother had—i. $\tfrac{5}{4}$.

A remarkable case of supernumerary teeth has been recorded by J. H. Gibbs.[1] A child aged two years and nine months exhibited

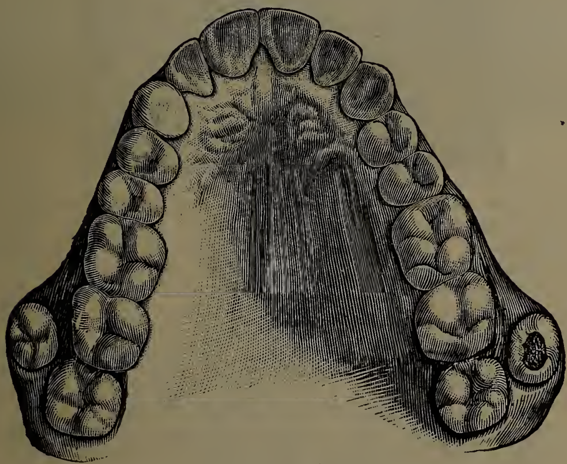

FIG. 44.[2]

a swelling of the right side of the mandible. All the deciduous teeth were fully erupted, and projecting through the gum below the level of the deciduous canine was a tooth composed of the geminated crowns of a deciduous lateral and canine. The swelling was opened and six teeth removed, which were found on examination to be four deciduous molars and two permanent molars, of which two of the deciduous molars and one of the permanent molars morphologically belonged to the left side.

The teeth removed from the tumour are shown in fig. 45. Unfortunately a skiagram of the case was not taken before operation. The drawing fig. 46 shows the relative position of the parts.

This case was probably of a teratomatous nature and was an example of reduplication of the alveolar portion of the mandible,

[1] *Trans. Int. Med. Cong.* (Stomatological Section), 1913.

[2] From *Dental Cosmos.*

and it is possible that the cases recorded by Blair and Handley were of a similar nature.

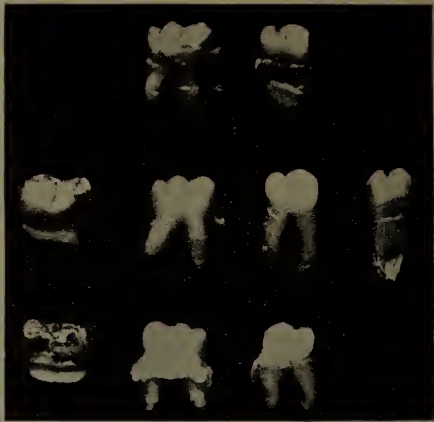

FIG. 45.—*Top row*—in use; *middle row*—geminated lateral incisor and canine, two deciduous molars and permanent molar; *bottom row*—two deciduous molars and permanent molar morphologically belonging to left side. (From *Proc. 17th Int. Med. Congress*, Stomatological Section.)

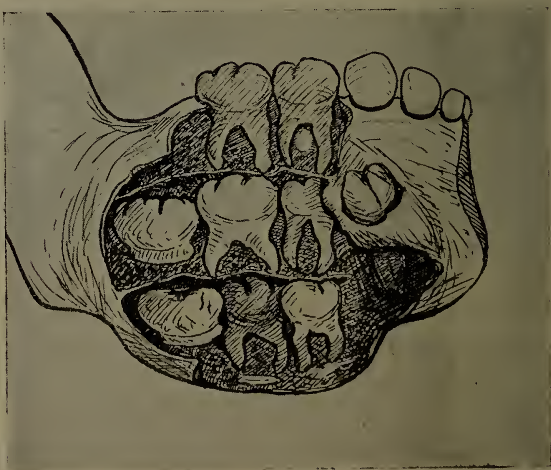

FIG. 46.—Drawing of the tumour made after the operation to show the relative position of the parts. (From *Proc. 17th Int. Med. Congress*, Stomatological Section.)

(ii) In this group many varieties are met with (fig. 47), but they may be conveniently grouped into two principal types—namely, the conical and the tuberculated (figs. 48, 49).

FIG. 47.—Varieties of supernumerary teeth.

FIG. 48.—Conical supernumerary tooth between the two central incisors.

FIG. 49.—Tuberculated supernumerary tooth replacing central incisor.

The *conical supernumerary teeth* are usually met with between the maxillary central incisors; more rarely they appear between the central and lateral incisors, or between the latter tooth and the canine. In fig. 50 the tooth is in an inverted position in the bone.

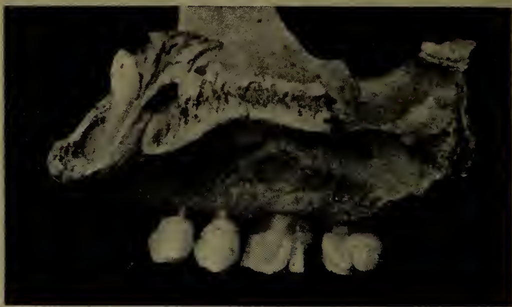

FIG. 50.

The cone-shaped supernumerary may erupt posterior to the incisor, and occasionally two extra teeth may be present, one in the left premaxilla, and the other in the right premaxilla.

These cone-shaped teeth are also found in the molar region, and at times appear as accessory cusps, being geminated with the molars.

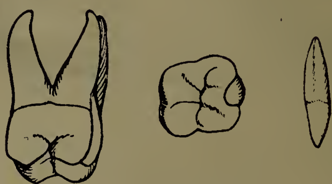

FIG. 51.

The case shown in fig. 51 is of interest, and is copied from the *Dental Cosmos*. The supernumerary here was quite free from the molar. In rare instances an extra tooth is present between the mandibular first and second molars on either side, and in a specimen in the Museum of the Royal College of Surgeons two small teeth are present in the position of the left mandibular first molar, these teeth having appeared after the removal of the first and second molars. In the specimen shown in fig. 52 three small cone-shaped teeth occupy the position of the right mandibular canine; and

E. Urbantschitsch[1] records a case where seven small teeth of different sizes erupted in the region of the right maxillary lateral and canine. Cone-shaped supernumerary teeth are met with, although rarely, between the deciduous upper central incisors.

Kirk[2] records a case in which thirteen supernumerary teeth occupied the position of the maxillary left central incisor which was

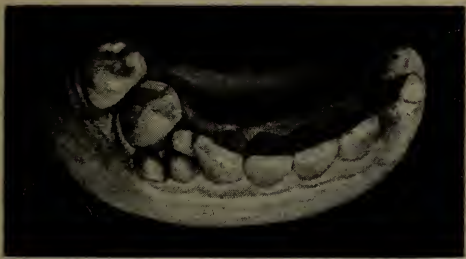

FIG. 52.

unerupted (fig. 53), and Dr. Huey describes a case in which thirty-five teeth were present in the bone in that position. As to the possible relation of this type of case to composite odontomes see p. 645.

FIG. 53.[3]—Kirk.

Four different views of the normal incisor, with its group of supernumerary satellites, in their correct relative position to one another.

The *tuberculated varieties* usually appear on either side of the median line immediately posterior to the upper central incisors which may be displaced. They are frequently symmetrical and give

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[1] Ash's *Quarterly Circular*, October, 1908. Translated from the *Oesterreich-Ungarische Vierteljahrsschrift für Zahnheilkunde*.

[2] *Dental Cosmos*, April, 1898, p. 281.

[3] From *Dental Cosmos*.

rise to a well-defined variety of irregularity (fig. 54). Two extra teeth of tubercular shape may be present in one premaxilla, but this condition is rare.

Abnormally shaped supernumerary teeth rarely have more than one root. A conical supernumerary tooth with two roots is shown in fig. 55.

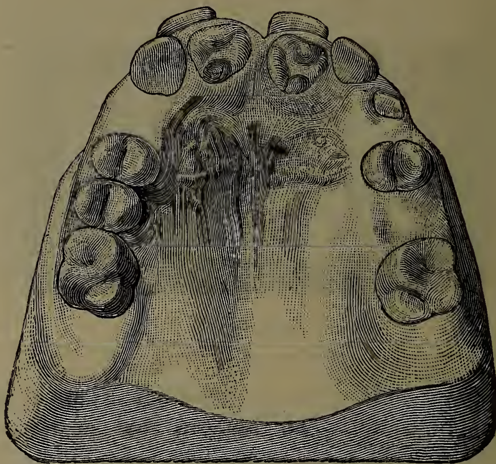

Fig. 54.—Two tuberculated supernumerary teeth immediately posterior to the central incisors.

Cases of Supernumerary Deciduous Teeth followed by Supernumerary Teeth in the Permanent Series.

A few cases have been recorded in which supernumerary deciduous teeth have been followed by supernumerary teeth in the

Fig. 55.—A conical-shaped supernumerary tooth with two roots. From the Museum of the Victoria Dental Hospital.

permanent series. In the *Transactions of the Manchester Odontological Society* (vol. iv, No. 6) G. Whittaker reports a case where two deciduous supernumerary mandibular incisors were followed by supernumerary teeth in the permanent series, and a similar case has been recorded by J. Ackery. An instance of an extra per-

manent lateral incisor preceded by geminated deciduous central and lateral incisors was recorded by A. Drake.[1]

The comparative scarcity of recorded cases may be no index of their actual frequency. Statistics of cases of this kind would be interesting and instructive.

Origin of Supernumerary Teeth.—It is difficult to account for the presence of supernumerary teeth. The ordinary cone-shaped variety appears in two situations, namely—near the median line towards the front of the mouth or in the region of the molars. In these regions masses of epithelium, called epithelial pearls, are frequently met with, and Bland-Sutton suggests that there may be a connection between the development of epithelial pearls and supernumerary teeth. J. G. Turner[2] considers that supernumerary teeth may have some connection with the developmental fissures of the face and neck.

W. H. Duckworth[3] has drawn attention to the occurrence in human crania of small dental masses which appear in the alveolar process of the maxilla and are nearly always found between the last premolar and the first molar. He discusses the possibility that these dental masses are the remains of deciduous teeth, and against this view he points out (1) that they rarely occur in the mandible; (2) that the various races of man present these appearances in altogether different degrees; and (3) that they occur systematically on both sides of the palate with comparative frequency. He inclines to the view that these fragments represent aborted teeth.

Treatment.—Supernumerary teeth, abnormal in shape, frequently appear before the permanent teeth. They should be removed as soon as they are recognized, but if their presence has been overlooked and the teeth are in a crowded condition it may be advisable, under certain conditions, to retain them.

(2) Deficiency in Number.—The deficiency may be limited to a single tooth or may extend to the whole series, but the commonest condition is that in which *one or two teeth* only are missing.

The maxillary laterals are, perhaps, most frequently missing; after these, the mandibular second premolars and the maxillary third molars. With regard to the absence of the maxillary third molars care must be taken to ascertain that the teeth supposed to be first and second molars are not in reality second and third molars, the first having been lost at an early age.

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[1] *Dental Record,* December, 1904, p. 555.

[2] *Trans. Odonto. Soc.,* vol. xxxii, p. 33.

[3] *Ibid.,* vol. xxxix, p. 58.

The absence of a maxillary lateral incisor on one side is often associated with mal-development of the corresponding tooth on the other side. Absence of the lateral incisors is met with in skulls of semi-civilized and barbaric races, and Wright[1] records such a case in the skull of a neolithic man. R. Clement Lucas[2] states that hare-lip and cleft palate in the child are often associated with the absence of the lateral incisors or with an ill-developed incisor in one of the parents.

The absence of the third molars would appear to be more common in highly civilized than in primitive races. Absence of one or both mandibular central incisors is a rare condition.

Persistence of the deciduous canine is met with in a large number of patients, mostly females. In these cases the permanent successor is always present, but is situated in an erratic position. The congenital absence of a tooth or teeth can only be determined by means of the X-rays.

The whole group of incisors, maxillary and mandibular, may be absent, occasionally the premolars, and very rarely the molars. In cases where a **large number of permanent teeth** are absent the first molars are usually present on either side in maxilla and mandible and one or two badly shaped teeth in the incisor region (fig. 56). An instance of marked deficiency of permanent teeth in twins aged sixteen years was observed by T. Clarence. Their dentitions were:—

$$\begin{array}{r|l} 76\ \ 4c\ 1 & 1\ c45\ \ 7 \\ \hline 6\ \ dcba & abc\ \ e \end{array} \quad \text{and} \quad \begin{array}{r|l} 76\ 4c\ 1 & 1\ c4\ 67 \\ \hline dcba & abc \end{array}$$

A very interesting case is recorded by Jarre.[3] There were no deciduous teeth until the age of fifteen months when a tooth conical in form appeared in the maxilla on the left side of the median line. Four months later a similar tooth appeared on the right side. At the age of twenty-three months a tooth erupted in the situation of the maxillary right lateral. About the third year two more teeth appeared in the maxilla on the right and left sides, the size and form of deciduous molars. No teeth appeared in the mandible. At the age of seven years the three teeth in the incisor region were replaced by three others, also conical in form. The deciduous molars were persistent at the age of twelve when the condition of the jaws was as follows: In the maxilla five teeth, three being

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1 *Proc. Roy. Soc. Med.*, vol. ii (Odonto. Sec.), p. 3.

2 *British Journal of Children's Diseases*, November 19, 1904.

3 *Dental Cosmos*, June, 1892, p. 468.

permanent, two deciduous; in the mandible no teeth. The hair on this patient's head was scanty, the scalp being plainly seen, while the rest of the body was entirely hairless. The nails presented peculiarities. They were covered with white opaque spots and streaks which occupied the whole thickness of the tissue, this

FIG. 56.—Models showing deficiency in the number of permanent teeth. The patient was a man, aged 35.

condition having been present since birth. The lenses were normal. The skin was loose and wrinkled. The fact that the nutrition of the teeth, hair and nails had been affected was interesting.

Where there is marked deficiency in the number of teeth, both sides of the jaws are usually affected, although not necessarily to

the same extent. For example, a girl aged nine years had no teeth on the left side of the mandible and only the deciduous canine, second deciduous molar and first permanent molar on the left side of the maxilla, while on the right side, only the first incisors in both maxilla and mandible were missing. The left side of the girl's scalp was almost totally devoid of hair.[1]

A case of **entire absence of teeth** accompanied by marked deficiency of hair is recorded by Guildford.[2] The patient, a man aged forty-eight, was nearly bald, there being only a slight covering of down. Hair was present in the pubic and axillary regions, but the surface of the body was entirely free from hair. The sudoriferous glands were absent or suppressed, for he had never perspired, and he had no sense of smell or taste. Of his six children two showed signs of inherited abnormality in having only about half the usual number of teeth.

A case of total absence of teeth in a boy aged sixteen is recorded by W. Rushton.[3] The only other abnormality associated with the condition was in the hair, which was of a soft character resembling wool.

Total absence of teeth in two brothers has been recorded by J. H. Gibbs.[4] There was definite abnormality of the skin, nails, hair and sudoriferous glands and a history of defective tooth formation in other members of the family, the defect being transmitted through the female parent.

Cases of **deficiency of teeth associated with abundance of hair** have been recorded. In the case of Andrian Jeftichfen,[5] the whole of the face, nose, forehead, cheeks, and ears was covered with long brown hair, which also extended partly down the back. His son, Fedor, at the age of three years showed the same tendency to hairiness. The father had no teeth up to seventeen years of age, and eventually only erupted four teeth in the mandible and one in the maxilla. The son Fedor, at the age of three, possessed only four incisors in the maxilla. The Burmese hairy family, consisting of grandfather, mother, and son, are said to have been deficient in the number of their teeth, but there is no reliable record.

From the foregoing cases it is evident that there is a correlation between the hair and the teeth. In one class there is deficiency

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1 Recorded by P. Ledger Etheridge (*Brit. Dent. Journ.*, January, 15, 1913).

2 *Transactions World's Columbian Dental Congress*, p. 257.

3 *Trans. Odonto. Soc.*, vol. xxxvi, p. 17.

4 *Dental Record*, November 1, 1915, p. 669.

5 *Brit. Journ. Dent. Sci.*, vol. xvi, p. 527.

of both structures; in the other deficiency of teeth is associated with redundance of hair.

W. A. Maggs[1] has recorded a case where **defective development of the permanent teeth** was **associated with malformation of the eyes and anus.** The patient was a girl, aged eighteen. The anus, imperforate at birth, was established by operation. In the maxilla, the incisors and molars were absent. In the mandible ten teeth were present; the teeth were badly formed. The condition of the eyes was as follows: Each eye was very deficient in size (microphthalmos); there was almost complete absence of irides, but the lenses were present, as ascertained by oblique illumination. Each eye had thirteen dioptres of myopia, and was not improved by spherical glasses. The ophthalmoscope showed the discs to be small. There was no coloboma of choroid, but a few patches of opaque nerve fibres were seen in the retina. Vision was defective in each eye. There was nothing suggestive of specific disease. The hair and nails were normal.

(2) Deciduous Dentition

Absence of one or more deciduous incisors, either maxillary or mandibular, is **not so common as an excess** in number. In shape supernumerary teeth simulate the neighbouring teeth. They are generally found in the incisor region. In a case which J. Ackery reported, the history of which he followed, the deciduous teeth in the incisor region were succeeded by six permanent teeth. A model showing two supernumerary deciduous incisors is shown in fig. 57 and one showing absence of a lateral incisor in fig. 58.

(C) VARIATIONS IN SHAPE

Certain variations in form, shape, or structure are included under this heading. They will be considered under the following subheadings:—

(1) Gemination.
(2) Enamel nodules.
(3) Variations in the number of cusps and roots.
(4) Variations from the normal, involving many teeth.

(1) Gemination.—This term is used to denote the union of two or more teeth by means of one or more dental tissues.

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[1] *Trans. Odonto. Soc.*, vol. xxii, p. 181.

(*a*) Permanent Dentition

Molars are sometimes geminated and also lateral incisors and canines, but gemination is very rare between canine and premolar, premolar and premolar, first molar and premolar.

Occasionally supernumerary and permanent teeth are geminated, usually in the molar region (fig. 66), but it is not uncommon to

Fig. 57.

find a central or a lateral incisor united with a supernumerary lateral, and, therefore, before expressing an opinion as to the absence of a permanent tooth, care should be taken to ascertain that it is not united to its neighbour; further, an abnormally large tooth should be differentiated from two geminated teeth.

Fig. 58.

Geminated teeth may be united throughout their entire length, or the union may be restricted to the crowns (figs. 59, 60).

The following figures show several forms of gemination. In fig. 61 two mandibular incisors united throughout their whole length are shown, while fig. 62 shows a similar condition in the maxillary teeth; fig. 60 is a specimen in which the crowns only are

united; in figs. 63, 64, 65 two molars are geminated; in fig. 66 a molar and supernumerary tooth are united; fig. 67 is a model showing symmetrical gemination of centrals with supernumerary laterals.

Fig. 59.

Fig. 60

Fig. 61.

Fig. 62.

Fig. 63.

Fig. 64.

Fig. 65.

Fig. 66.

An example of gemination between two maxillary premolars is shown in fig. 68, in fig. 69 is shown a specimen composed of four premolars grown together, and in fig. 70 two mandibular premolars are seen wrapped round one another. When the crowns alone are united, the union of geminated teeth is by continuity of both dentine and enamel; but when the union extends the whole length of the

tooth there is also a continuity of cementum. Geminated teeth may have a single or two separate pulp chambers.

A curious case of gemination has been recorded by E. Goodman.[1] The mass occupied the position of the maxillary right central incisor,

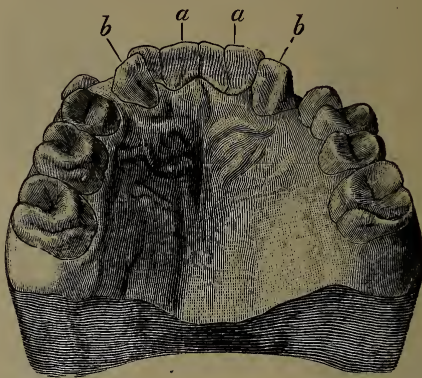

Fig. 67.—*a*, geminated central and supernumerary lateral incisors; *b*, lateral incisors.

Fig. 68.

Fig. 69.

Fig. 70.

Fig. 71.[2]

Fig. 72.[2]

and was found to be composed of three distinct teeth, the appearance presented being shown in figs. 71 and 72; the lateral incisor was present.

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[1] *Journ. Brit. Dent. Assoc.*, vol. xv, p. 28.

[2] From *Journ. Brit. Dent. Assoc.*

There is reason to believe that some of the abnormally shaped teeth, formerly termed *odontomes coronaires*, are in reality examples of gemination. The specimen shown in fig. 73 proved, on section, to be two geminated teeth (see fig. 74).

FIG. 73.[1]—This tooth was removed from the region of the mandibular second molar.

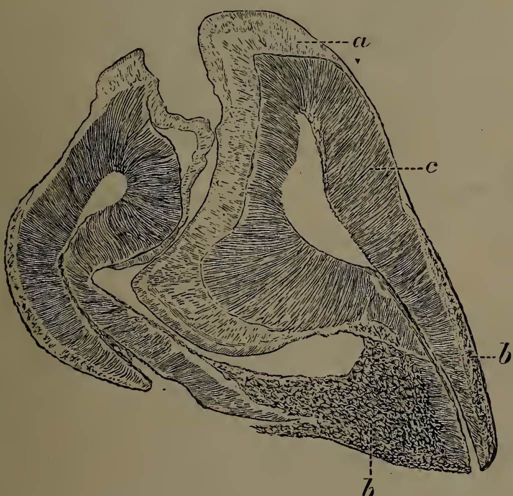


FIG. 74.[1]—Section of fig. 73—*a*, enamel; *b*, cementum; *c*, dentine.

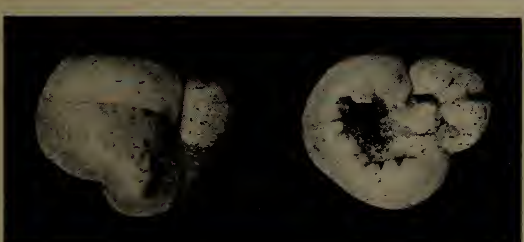


FIG. 75.

The specimen illustrated in fig. 75 was removed from the region of the mandibular third molar. The section fig. 76 shows that it is

[1] From *Journ. Brit. Dent. Assoc.*

an example of gemination of a third molar with a supernumerary molar, the pulp chambers of the two teeth forming a single cavity.

Fig. 76.—*a*, enamel; *b*, dentine; *c*, cementum; *d*, pulp cavity; *e*, filling material.

(*b*) Deciduous Dentition

Geminated teeth are more often found in the deciduous than in the permanent dentition. They are rarely symmetrical, and occur in the mandible more frequently than in the maxilla. The lateral incisor and the canine are the teeth generally united, but gemination of the central and lateral incisors has also been recorded. W. Hern has recorded a case in which geminated teeth were followed by the absence of a permanent incisor in the same region, and this

(*a*) (*b*) (*c*)
Fig. 77.

Fig. 78.

Fig. 79.

Fig. 80.

Fig. 81.

Enamel nodules.

would seem to indicate that only one germ was given off from the two teeth.

In some cases the line of fusion is well marked (fig. 77, *a* and *b*), but in others it is scarcely perceptible (fig. 77, *c*). The union is by continuity of dentine with dentine, and in some examples the

Fig. 82.—Maxillary molar with two enamel nodules.

Fig. 83.—Maxillary molar showing large enamel nodule.

pulps coalesce. An example of gemination of three deciduous teeth is shown in fig. 78.

(2) Enamel Nodules.—Enamel nodules are those small excrescences, apparently consisting of enamel, which are occasionally met with upon the roots of teeth. They are generally found upon

Fig. 84.—Section through an enamel nodule upon a maxillary second molar.

multiple-rooted teeth, being situated in a position a little below the neck, and often at the junction of two roots. On section, they are found to consist of a cone of dentine covered with a fairly thick layer of enamel (fig. 84). It will often be found that a sharp lamina of enamel connects the nodule with the crown of the tooth.

Although generally seen upon multiple-rooted teeth, enamel nodules are occasionally met with on teeth with single roots. Enamel nodules are mostly found on the maxillary molars, and are situated between the palatine and buccal roots.

If a supernumerary root is present the enamel nodule is placed between the anterior aspect of the palatine root and the supernumerary root. In specimens showing two enamel nodules, in addition to an extra root, one nodule is usually situated between

Fig. 85.

the supernumerary and the palatine roots and the other between the supernumerary root and the anterior buccal root. Occasionally an enamel nodule is found springing from a point halfway up the anterior aspect of the palatine root of the maxillary molars.

In the Museum of the Royal College of Surgeons there is an example of an enamel nodule on the single root of a supernumerary tooth and another of a mandibular molar with a large enamel nodule occupying the position of the posterior root.

Fig. 86.—Prolongation of enamel between the roots of a mandibular molar.

Fig. 87.—Prolongation of enamel between the roots of a maxillary molar.

The specimen (fig. 83) represents a very large nodule between two palatine roots of an upper molar, while that in fig. 85 shows a nodule situated at the apex of the root of a maxillary molar.

The transition from enamel nodules to supernumerary cusps or teeth and also to those prolongations of enamel which are seen running between the roots of multiple teeth, especially upper molars (figs. 86 and 87), is probably one of degree only. Enamel nodules may be accounted for by dichotomy of the developmental germ, that is to say, a budding from the tissues connected with the

process of tooth formation; but Wedl, in accounting for them, says: "It is obvious that the nodules or ridges which are met with upon the molars are the result of localized continuations of the development of the enamel between the already developed basal portion of the roots, and are produced by the strip of the enamel organs which has persisted longer than the rest."

(3) Variations in the Number of Roots and Cusps, and in the Direction of the Roots.—In dealing with this division it is only possible to consider a few of the more common varieties. The variations from the normal caused by flexions and torsions of the roots are almost endless; in most instances these variations are due to movements of the developing tooth in mal-directions through crowding. The flexion of the root may take place at any part of the root from the neck to the apex, and may be single or multiple. The twisting varies considerably in degree.

(*a*) **Permanent Dentition**

(1) Maxillary Teeth

(*a*) *Central Incisor.*—The following are some of the variations in shape met with:—

(i) A considerable flattening from before backwards (fig. 88).

(ii) The crown altered so as to resemble a simple cone (fig. 89).

(iii) Disproportion between length of crown and root (fig. 90, *a*, *b*).

(iv) Disproportion between width of the crown and the root (fig. 90, *d*).

(v) Marked development of the posterior cervico-marginal ridge (fig. 90, *c*).

(vi) Groove running from the posterior cervico-marginal ridge on to the root (fig. 90, *g*).

(vii) A bending in of the mesial aspect of the tooth near the neck (fig. 90, *c*).

(viii) A bending in the axis of the root and the crown.

(ix) A peculiar shape of the labial surface due to thickening of the mesial and labial margins.

(x) A projection from the labial aspect (fig. 90, *f*).

(xi) An extra root (fig. 91).

(xii) Curvation of the terminal portion of the root (uncommon) (fig. 90, *e*).

(*b*) *Lateral Incisor.*

(i) Variation in shape of the crown, the mesial and distal angles being so rounded as to cause the tooth to mimic a canine.

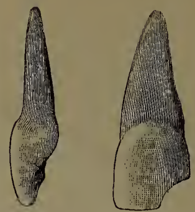


Fig. 88.

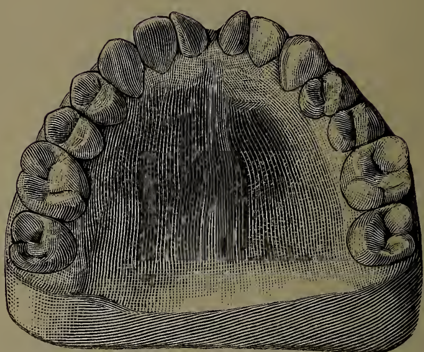


Fig. 89.

(a) (b) (c) (d) (e)

(f) (g)

Fig. 90.

(ii) The crown so altered as to appear as a simple cone.

(iii) Pronounced lingual fossa due to development of the posterior cervico-marginal ridge (fig. 92, *c*).

(iv) Development of a cusp from the posterior cervico-marginal ridge, accompanied by a groove running down the root (fig. 92, *d*).

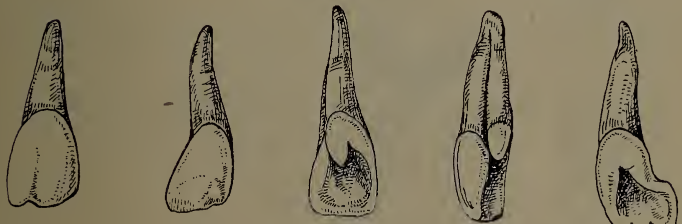
(v) A notch on the cutting edge towards the mesial angle (fig. 92, *a*).

(vi) The root may be considerably flattened and grooved laterally.

(vii) Curvature of the root (common) (fig. 92, *b*).

(viii) Depression in the mesial aspect of the root near neck (fig. 92, *b*).

FIG. 91.



(*a*) (*b*) (*c*) (*d*) (*e*)

FIG. 92.

(ix) A kink on the mesial aspect of the crown (fig. 92, *e*).

(x) An extra root.

(*c*) *Canine.*

(i) Excessive length of root. The tooth may measure $1\frac{1}{4}$ in.

(ii) The root may be grooved and bifurcation of the apex may take place. (The latter is very rare.)

(iii) Flexion of the root, met with principally in those teeth which erupt external or internal to the arch.

(iv) Development of a cusp from the posterior cervico-marginal ridge. This irregularity may be so marked as to cause the tooth to mimic a premolar.

(v) The cutting edge may be divided into two unequal cusps by a notch.

(*d*) *Premolars.*—**The first premolar** is very irregular in regard

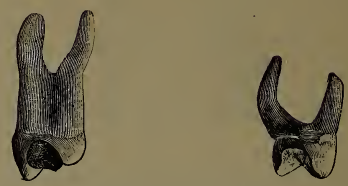


Fig. 93.—Two-rooted maxillary first premolars.

Fig. 94.—Three-rooted maxillary first premolars.

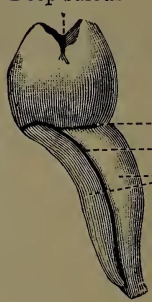


Fig. 95.[1]—Side view of tooth.

Fig. 96.[1]—Anterior view of tooth.

[1] From *Journ. Brit. Dent. Assoc.*

to the form and number of its roots. Externally the root nearly always shows signs of bifurcation, and in some cases possesses two or three well-defined roots. When there are three roots they are arranged on the same plan as in the maxillary molar.

A curious first premolar is shown in figs. 95 and 96.[1]

The second premolar is more constant in form than the first premolar. Two or three roots may be present. An extra cusp occasionally appears on the premolars (fig. 97).

Fig. 97.

Fig. 98.—Maxillary first molars, with supernumerary roots between the anterior buccal and palatine roots.

(*e*) *Molars.*—**The first molar** may have a fourth root. The fourth root is always situated between the anterior buccal and the palatine roots. A fifth root is occasionally seen. The roots may be fused together, a union of the posterior buccal and palatine being most common (fig. 99). At times all three roots may be fused together (fig. 100). H. P. Pickerill[2] has recorded an interesting variation

Fig. 99.—Maxillary first molar, the posterior buccal and palatine roots being united by cementum.

Fig. 100.—Maxillary first molar, showing all three roots united by cementum.

[1] Described by J. F. Rymer, *Journ. Brit. Dent. Assoc.*, vol. xvi, p. 162.

[2] *Proc. Roy. Soc. Med.* (Odonto. Sec.), vol. ii, p. 150.

of the first maxillary molars (fig. 101). The crowns were large but normal in shape; the apices, instead of being conical, presented a large, uneven quadrilateral surface, the naked-eye appearance

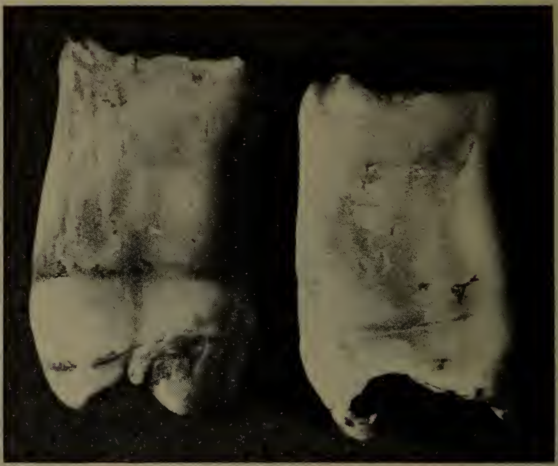


FIG. 101. × $2\frac{1}{2}$.
From *Proc. Roy. Soc. Med.*

FIG. 102. × 2.
From *Proc. Roy. Soc. Med.*

suggesting that four roots had spread out, become fused, and the centre filled in with a plug of cementum. A section (fig. 102) showed one large central quadrilateral pulp cavity surrounded by a circular

and parallel wall of dentine. The buccal roots of the maxillary molars are often curved, and may approximate at their apices so as to embrace the septum.

An extra cusp is often seen on the mesio-lingual and, occasionally, on the buccal aspects. There is some evidence that the extra cusps in the latter situation are really due to gemination with a supernumerary tooth.

The second molar may present abnormalities similar to the first. A peculiar flattening of the tooth, as shown in fig. 103, is met with.

Fig. 103.—Abnormally shaped maxillary second molars.

The third molar presents an immense variety of shapes. The roots may be all fused together, and in one specimen in the Museum of the Royal College of Surgeons the apex is cup-shaped with numerous holes for the vessels of the pulp to enter. The roots may be increased in number, and flexions are often present (figs. 104 and 105).

Fig. 104.—Abnormal maxillary third molar.

Fig. 105. — Maxillary third molar, showing a peculiar flexion of the buccal roots.

The normal position of the roots of the molars may be altered by the posterior buccal root being displaced inwards and forwards. This variation is termed "oblique rooted," and attention was first drawn to it by Booth Pearsall[1] (see figs. 106 to 109).

(2) Mandibular Teeth

(*a*) *Incisors.*

(i) The crown may be altered so as to resemble a single cone.

(ii) A notch may be present on the cutting edge (fig. 110, *a*).

(iii) A thickening may occur on the labial aspect in the median line (fig. 110, *b*).

[1] *Journ. Brit. Dent. Assoc.*, vol. x, p. 38.

(iv) An extra root may arise from the approximal or lingual surface.

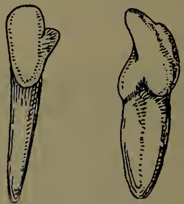
(*b*) *Canine.*—The root may be bifurcated (fig. 111), or an extra root may be present. In the case of bifurcation the variation usually occurs in both canines.

FIG. 106.—Normal left maxillary first molar.

FIG. 107.—Oblique-rooted left maxillary first molar.

FIG. 108.—Normal right maxillary second molar.

FIG. 109.—Oblique - rooted right maxillary second molar.



(*a*) (*b*)

FIG. 110.

FIG. 111.—Two-rooted mandibular canine.

(*c*) *Premolars.*—**The first premolar** may have two roots. "When a lower premolar tends to have two roots they are peculiarly formed, the flattened apex being bent round so as to form an approach to a second (anterior) root, and this may go on to complete division," fig. 112 (Tomes). The inner cusp of this tooth is at times feebly developed and the tooth simulates a canine.

The second premolar is more constant in form than the first. This tooth often has a square-topped crown and presents an extra cusp. A curious abnormality of the second premolar is shown in fig. 113, the crown somewhat resembling that of a molar.

(*d*) *Molars.*—**The first molar** may have an extra root on the lingual aspect, situated either between the normal roots, or further

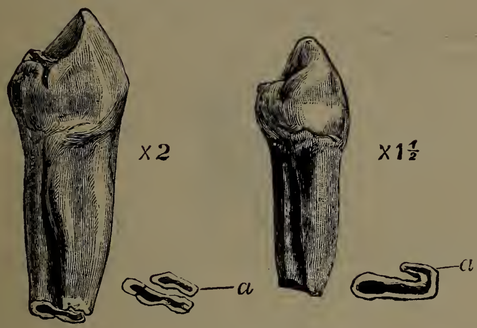


FIG. 112[1]

Two mandibular premolars, the roots of which show two stages towards complete division. *a,* Anterior root.

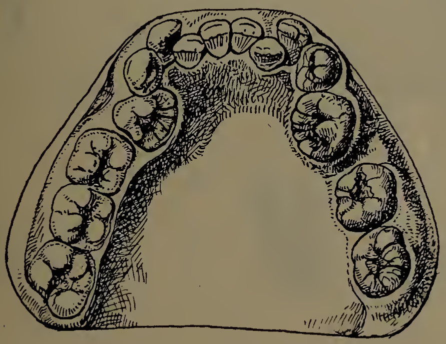


FIG. 113.

back when it displaces the posterior root outwards. Rarely an extra root is seen on the buccal side of the tooth (fig. 115). Four are met with (fig. 116). The roots are occasionally fused together, and the normal backward curve may be much exaggerated. Five or even six roots are recorded, but these cases are probably examples of gemination. Extra cusps are met with on the buccal surface.

[1] From Tomes' "Dental Anatomy."

The second molar presents abnormalities similar to those found in the first molar; but fusion of the roots of the second molar (fig. 117) is more common than in the first molar.

The third molar presents an increased number of cusps, or the whole tooth may be reduced to a comparatively small size. The roots are often fused together and curved well backwards. At times they are grooved by the mandibular nerve, and cases are recorded in which a foramen has existed for the passage of the nerve. In

Fig. 114.—First mandibular molar with three roots.

Fig. 115.—First mandibular molar with supernumerary root.

Fig. 116.—Four-rooted first mandibular molar.

Fig. 117.

Fig. 118.

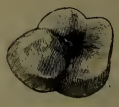


Fig. 119.

one variety the roots are fused together, but bifurcate towards the apices and present four small roots (fig. 118). A peculiar abnormality of the posterior external cusp is shown in fig. 119.

In some individuals there appears to be an abnormally strong tendency towards tooth development which manifests itself in the production of extra cusps and supernumerary teeth. For example, in one case a cone-shaped supernumerary was found in the left premaxilla, and extra cusps were present on the second deciduous and the first permanent molars.

(*b*) Deciduous Dentition

Additional cusps and variation in the number of the roots are more rare in the deciduous than in the permanent dentitions. The second molar, occasionally, has an additional cusp. Cases of strongly pronounced cusps arising from the posterior cervico-marginal ridge of the incisors and canines are met with.

Variations in the number of the roots occur in the molar region. The maxillary second molar may have four roots and the mandibular three. Occasionally, the root of the mandibular canine is bifid.

Variations from the Normal, involving many Teeth.—A few cases of this character have been recorded. One which occurred in the practice of C. Robbins[1] is shown in fig. 120. In two sisters of this patient a similar condition existed, though not so well marked, and some cousins were also stated to have exhibited the same peculiarities. The models are interesting, as they throw light upon the genesis of the cusps.

The remarkable abnormalities of teeth shown in figs. 121 to 123 were recorded[2] by H. Moon. The models were taken from the mouths of two sisters, one aged 11 (fig. 123) and the other aged 15 (figs. 121 and 122). The hair of the younger sister was short, fine, and scanty. Her eyes were of a grey colour, remarkably small, the sight of the left eye being defective from birth. The hair on the scalp of the elder sister was short and scanty, but very fine hairs in more than usual number were developed on the temples and cheeks.

(D) ANOMALOUS TEETH

Under this general heading it is proposed to give a brief description of a few types of anomalous teeth which cannot at present be definitely classified. A more thorough examination of specimens will probably admit of a more exact classification, and when this has been done the way may be open to ascertain how they are correlated to other pathological processes of the teeth.

The editors of the Report on Odontomes issued by the British Dental Association have included these anomalous teeth among the odontomes, but this is not in keeping with the accepted views of general pathology. An odontome is grouped amongst the blastomas (ordinary tumours), that is, tumours exhibiting an independent,

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[1] *Trans. Odonto. Soc.*, vol. xxiii, p. 80.

[2] *Trans. Odonto. Soc.*, vol. ix, p. 232.

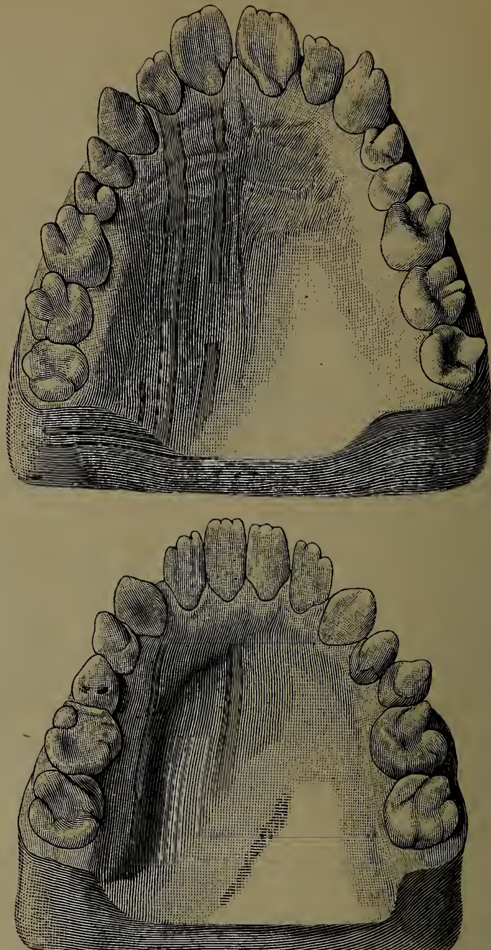

Fig. 120.

Fig. 121.

localized growth and arising in a body by proliferation of cells belonging to that body. The unknown stimulus starting the growth is extrinsic in origin. The anomalous tooth, on the other hand, is an abnormality of development and is inherited, that is, arises from an intrinsic cause.

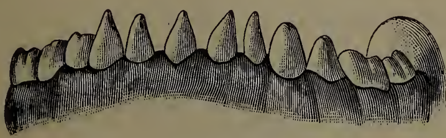

Fig. 122.

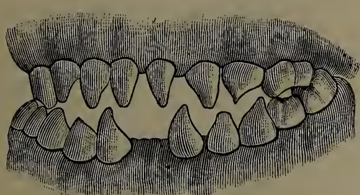

Fig. 123.

(c) (b) (a)

Fig. 124.[1]—*a*, view from base; *b*, view from posterior aspect; *c*, lateral view.

Abnormally shaped teeth which show a somewhat similar type of structure to one another are met with in the premaxillary region. In fig. 124 is shown an irregularly shaped tooth removed from a boy about 17 years of age. There was a sinus in the alveolar process and this led to a cyst-like cavity. It will be seen on

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[1] From *Trans. Odonto. Soc.*

examination that the specimen is cone-shaped, the base of the cone embracing a curious nodular mass which is fused with the base of the cone at the posterior or palatal aspect. A section through the specimen is shown in fig. 125. The outer coat consists of enamel and cementum; within this is dentine, and within this again and lining the large space in the centre of the tooth is enamel. Near the occlusal margin of the tooth the dentine forms a thin streak, the two layers of enamel almost touching each other at this part. In its upward extension on the labial aspect the dentine increases in thickness, and, in the upper two-thirds, surrounds a pulp

FIG. 125.[1]—*a*, enamel; *b*, dentine; *c*, pulp cavity of external tooth; *d*, cavity lined with enamel; *e*, mass of cemental-like tissue.

chamber; whilst in the posterior or palatal wall the dentine extends upwards until, by means of a very vascular dentine, it becomes continuous with the curious circular mass of tissue embraced by the base of the cone. This globular mass shows in section a well-marked concentric lamination, and is composed of vascular cemental tissue.

S. J. Hutchinson[2] has described a similar specimen (fig. 126) in which the abnormality has advanced a stage further than in the

[1] From *Trans. Odonto Soc.*

[2] *Trans. Odonto. Soc.*, vol. xi, p. 163.

specimen shown in fig. 124 inasmuch as the dentine has almost encircled the mass of cemental-like tissue. In some of these teeth the enamel of the exterior is continuous with the enamel lining the

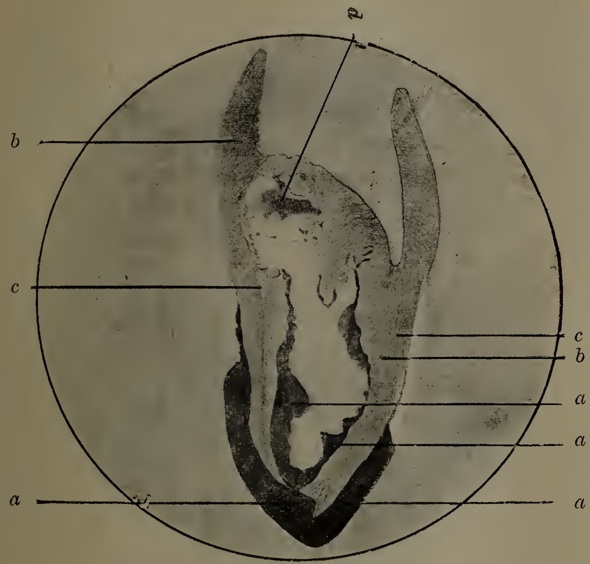

FIG. 126.[1]—*a*, enamel; *b*, dentine; *c*, pulp chamber of external tooth; *d*, mass of cemental tissue.

FIG. 127.[1]

cavity inside the tooth. This is seen in the tooth shown in figs. 127 and 128. The dentine here completely surrounds the internal layer of enamel.

[1] From *Trans. Odonto. Soc.*

These specimens seem to form a fairly complete series. It is not clear how the enamel-lined cavity arises. It may be due to an invagination of the enamel organ of the tooth, or it may be the result of the enamel organ of one tooth being pushed, as it were, into the dentine papilla of another. The specimens (figs. 125 and 126) seem to support the latter view. In the specimen shown in fig. 125 the concentric mass was probably independent of the original aberration and should be regarded as an enlarged pulp nodule which has fused with the developing tooth.

A tooth of remarkable shape is shown in fig. 129. There is no history of the case, but the shape of the crown would seem to

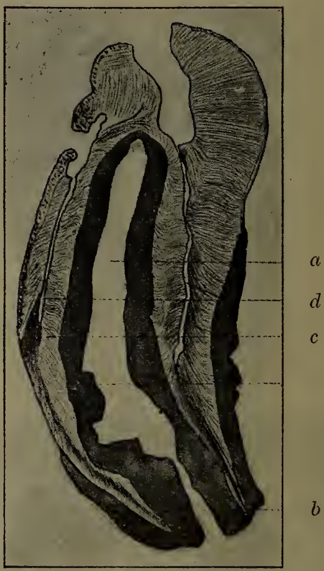

FIG. 128.[1]—*a*, enamel; *b*, space leading from exterior of tooth to cavity in the centre; *c*, dentine; *d*, pulp cavity of external tooth.

indicate that the tooth is a central incisor. The root and crown form a curve, the concavity being towards the palatal aspect. Springing from the inside of the curve, about one-third the way from the occlusal margin, is a big loop of tooth tissue. A section of the specimen shows the tissues to be arranged as shown in fig. 130. It is difficult to form a theory as to the origin of the specimen as part of the tooth has been destroyed by caries.

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[1] From *Trans. Odonto. Soc.*

FIG. 129.[1]—*a*, view of the upper aspect; *b*, view of the lateral aspect; *c*, view of the posterior aspect.

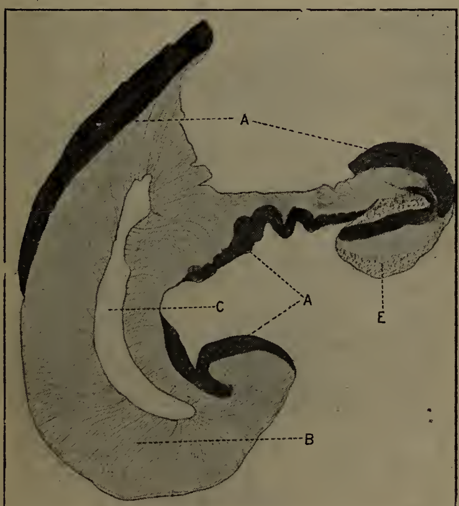

FIG. 130.[1]—A, enamel; B, dentine; C, pulp cavity; E, cementum.

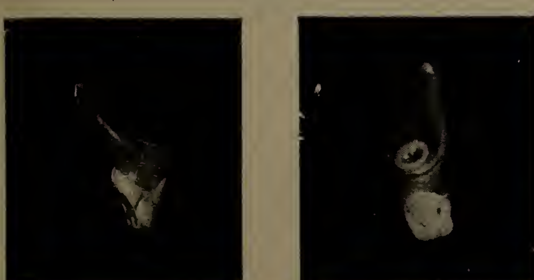

FIG. 131.[2]

[1] From *Trans. Odonto. Soc.*
[2] From *Brit. Dent. Journ.*

In fig. 131 is shown a curious tooth removed from the region of the right maxillary lateral incisor. The root is flattened from above downwards and is bent at an angle to the crown. Situated in the root just above the neck of the tooth is a ring of enamel.[1] A specimen somewhat similar in character to the one just mentioned is described by J. E. Freeston.[2] The tooth occupied the position of the left maxillary canine. Views of this tooth are shown in figs. 132 and 133.

FIG 132.[3]—Buccal view.

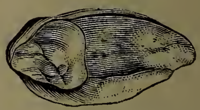

FIG. 133.[3]—Under-surface view.

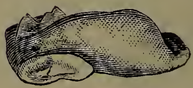

FIG. 134.[3]—Palatine view.

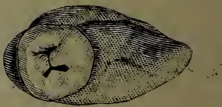

FIG. 135.[3]—Upper-surface view.

FIG. 136.

The tooth shown in fig. 137 was removed from the region of the right maxillary central incisor. The section of the tooth shows that there are three distinct canals communicating with what appear to be three distinct pulp cavities (fig. 136).

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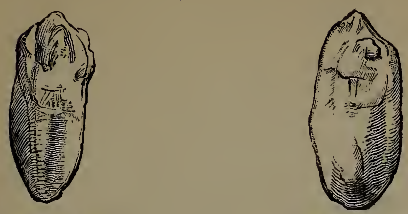
[1] Recorded by J. Coltman, *Brit. Dent. Journ.*, vol. xxviii, p. 243.

[2] *Dental Cosmos*, March, 1890.

[3] From *Dental Cosmos*.



Frontal view. Lateral view.

FIG. 137.[1]

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[1] From *Dental Cosmos*.

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CHAPTER IV

Defective Formation of the Teeth

Defects produced by Syphilis—Hypoplastic Teeth—Hereditary Hypoplasia—Defects due to Local Causes

(A) DEFECTS PRODUCED BY GENERAL CAUSES

(1) Syphilis.—It is an established fact that congenital syphilis may produce a characteristic deformity of certain of the teeth. The manner in which syphilis affects the eruption of teeth was referred to on p. 28. In this chapter it is proposed to deal with the anatomical condition of the deformity. The teeth generally affected are the permanent incisors, both upper and lower, at times the canines, and frequently the first molars.

FIG. 138.[1]—Model showing syphilitic incisors.

Syphilitic incisors are small, pegtop-shaped teeth (fig. 138). The distal margins of the centrals are generally turned outwards, and it will also be noticed that the alveolar portion of the jaw in the incisor region is imperfectly developed. The teeth are generally affected symmetrically, but exceptions occur, for example, when one incisor is perfectly formed and the other presents the typical syphilitic form.

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[1] From a photograph by G. G. Campion.

In a healthy tooth when just erupted, the cutting edge is seen to be surmounted by three little tubercles separated by two shallow notches, and, the tubercles being rapidly worn down by attrition, the cutting edge soon appears quite straight. In the syphilitic tooth these tubercles and notches are well marked but the central tubercle is badly developed, and the effect of attrition is to produce one central notch between the two outside tubercles. It is this central notch that is said to give to syphilitic teeth one of their characteristic appearances, but, as will be subsequently shown, it must not be solely relied upon in diagnosis, as it also appears to be produced in teeth where there is not the slightest taint of congenital syphilis. It is said that syphilitic teeth are soft in structure and are therefore readily attacked by caries or quickly worn by mastication. Many patients, however, are seen with characteristic

(*a*) (*b*)

Fig. 139.[1]—The syphilitic molar (*a*) is shown in contrast with a normal-shaped molar (*b*)—both slightly enlarged. The patient from whom the syphilitic molar was removed was under the care of E. P. Collett. There was a typical history of congenital syphilis.

syphilitic teeth in which the enamel appears to be quite normal. The laterals are not always deformed, the centrals being considered by Jonathan Hutchinson as the "test" teeth. Leon Williams has found, in the case of a syphilitic tooth which he examined microscopically, that the enamel was of very faulty character and that the dentine contained interglobular spaces in abundance.

The deformity of syphilitic canines shows itself by a circumferential notch occurring near the cutting edge or point of the crown. Syphilitic molars, like the centrals, are smaller than normal. They are dome-shaped, and the crown surface is of an irregular pattern, instead of having well-developed cusps (see fig. 139).

[1] From a photograph by G. G. Campion.

The *Spirochæta pallida* is to be found in the dental follicles in proximity to the vessels and their walls. Figs. 140 and 141 are from a paper by Pasini.[1]

Cavallaro, in an exhaustive paper on the Relation of Syphilis to Dentition,[2] confirms the discovery of Pasini that the *Spirochæta pallida* is to be found in abundance in the dental follicle. He shows that a curious modification of the lower ends of growing teeth can often be demonstrated in the form of a constriction of the dental

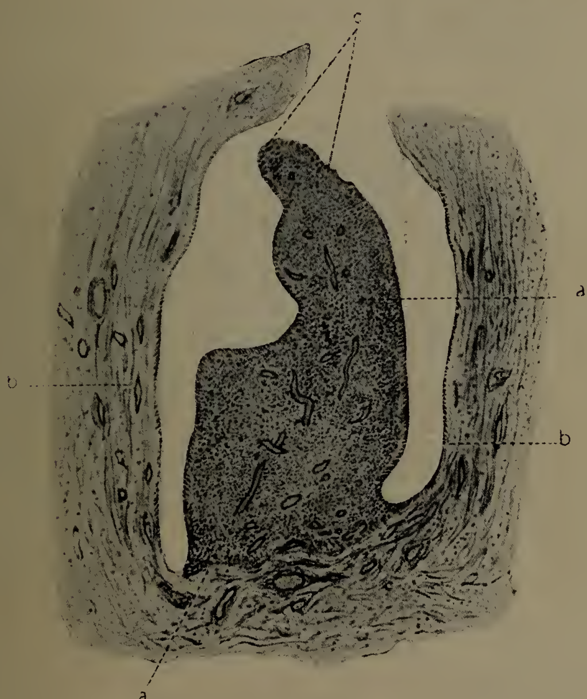

FIG. 140.—*a*, dental papilla; *b*, dental sac; *c*, free extremity of the papilla.

papilla which clinically corresponds to the atrophy of the tooth cusps so often seen. He states that at this part certain changes can be noted in the pulp tissue, the nuclei are better stained, and the infiltration of the embryonal cellular elements is more intense. He also has found in the dental follicles the following alterations—

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[1] "Demonstration of the *Spirochæta pallida* in the Dental Follicle of a Congenital Syphilitic," *La Stomatologia*, November, 1908, p. 5.

[2] *Dental Cosmos*, November and December, 1908; January and February, 1909.

namely, endovasculitis, perivasculitis, and hæmorrhage. In addition to the changes in the follicle already referred to, he finds certain histo-chemical alterations in the enamel and dentine.

The diagnosis of syphilitic teeth. Syphilitic incisors must be diagnosed from (*a*) the tapering notched tooth occasionally seen in patients who have suffered from rickets; (*b*) hypoplastic incisors, where the deformity is confined to the edge and the central portion wears down more rapidly than the side. The notch produced upon the teeth by the use of a clay pipe should not be mistaken for a syphilitic notch, as it would be unilateral and altogether different in

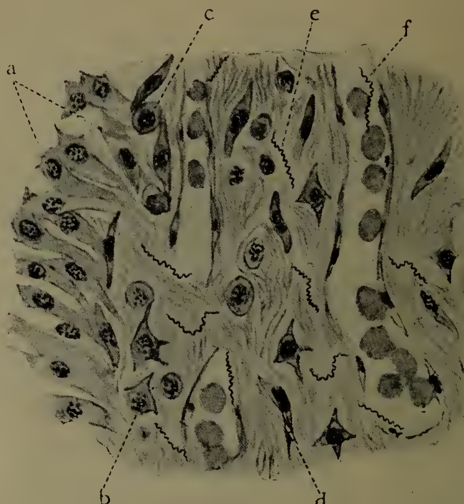

FIG. 141 (from part (*c*) of fig. 140).

(*a*) Odontoblasts of irregular shape and distribution.
(*b*) Polygonal cells, (*c*) Round cells, (*d*) Fusiform cells } of the dental papilla.
(*e*) *Spirochæta pallida* situated in the gelatinous tissue of the dental papilla.
(*f*) *Spirochæta pallida* situated in the lumen of a capillary and partly attached to the endothelium.

character. The diagnosis of congenital syphilis can also be confirmed by the presence of other lesions, such as scars radiating from the angles of the mouth, dusky-coloured skin, prominent forehead, broad depressed bridge of nose, and interstitial keratitis.

Children who suffer from phagedænic ulceration of the mouth, syphilitic in origin, are generally free from the typical teeth. It is as well to remember that the diagnosis of congenital syphilis by no means rests upon the presence or absence of these teeth, for they

are only met with in a small proportion of cases. H. Moon has suggested an explanation of the deformity. He believes that "the peculiar shape results from a stunted development of the first formed portion of dentine, in other words, a dwarfing of the cusps; and that the single central notch on their cutting edge is due to a greater diminution in the size of the central than the lateral lobes."

The lesions on the teeth caused by syphilis are usually found on the incisors and first molars of the permanent series, and this is to be attributed to the fact that the maximum intensity of the virulence is during the last months of intra-uterine life and the first three months of extra-uterine life, which is the period when those teeth are forming. Welander[1] reports the case of a lad who acquired syphilis between three and four months of age from his nurse. In this patient, the tooth characteristic of syphilis was present.

The deciduous teeth do not always escape and the characteristic lesion is occasionally met with in the incisors.[2] The probable explanation of the comparative immunity of the deciduous teeth is that they are formed in the early months of uterine life when syphilis rarely manifests itself, and if it does appear during that stage it usually tends to abortion.

(2) Gout is said to produce characteristic teeth, but on careful examination it will be found that the "characteristics" are merely the result of early recession of the gums combined with marked attrition of the masticating surfaces, these conditions making the teeth appear bony with squarish tops.

(3) Hypoplastic Teeth (Honeycombed Teeth).—To the naked eye this condition is characterized by a defective formation of the enamel, accompanied, in many cases, by a stunted growth of the portion of the tooth affected.

In the type of hypoplastic teeth usually met with, the first molars, together with the incisors and canines, are affected, the defect extending from the cutting edges, and involving, in severe cases, the whole of the crown surfaces. In mild cases the enamel presents only a slight pitting; in more advanced conditions the enamel is dark in colour and presents numerous deep pits, while in severe cases the enamel covering is slight and the cutting edge of the tooth presents sharp points, which give the tooth a curious spine-like appearance. In another variety the enamel is simply deficient in quantity and shows little or no pitting. In some cases

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[1] *Nord. Med. Archiv.*, vol. 27, No. 3.

[2] See case recorded by G. F. Still, *The Practitioner*, July, 1904.

the rows of pits run transversely across the tooth separated from one another by well-formed enamel; while other examples are seen

Fig. 142.—Hypoplastic maxillary incisors, canines and first molars from the mouth of a patient who had suffered from rickets.

Fig. 143.—Examples of hypoplastic maxillary central incisors.

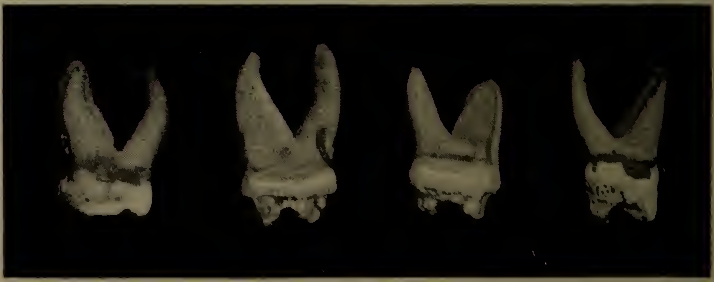

Fig. 144.—Examples of hypoplastic first maxillary molars.

in which the surface of the tooth shows transverse grooves, the enamel everywhere presenting a smooth, glossy appearance. In

rare instances the defects run in a vertical direction. Occasionally the enamel towards the cutting edge of the tooth may be well formed, the defect starting beyond this point. The amount of deformity may be limited to a transverse band of tissue situated in any part of the crown. Examples of hypoplastic teeth are shown in figs. 142 to 144A.

As previously mentioned, the incisors, canines and first molars are the teeth usually involved in severe cases; the premolars, second and third molars may also be affected. On the other hand, the deformity may be limited to the occluding surfaces of the first molars. In cases where the defect in the incisors is limited to the centre of the cutting edge, this portion wears down at a greater pace than the sides, and a well-marked notch is produced which must be carefully discriminated from the notch resulting from syphilis.

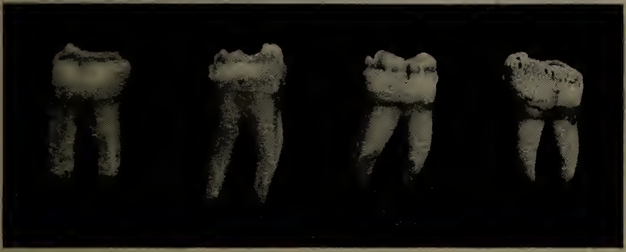

Fig. 144A.—Examples of hypoplastic first mandibular molars.

In the skulls of monkeys and other animals showing rickets hypoplastic teeth are occasionally seen. The specimen shown in fig. 145 is from an Abyssinian lion about 5 years old. The canines, from the tips to half-way up the crowns, are practically devoid of enamel, and the incisors, premolars and molars all show defective enamel in places. The *post-mortem* on this animal revealed a condition simulating acute osteo-arthritis.

Hypoplastic teeth are met with in the deciduous dentition.

Microscopical Appearances.—The enamel will be found to be extremely thin in the position of the pits or grooves, and may be entirely absent. The striation of the enamel prisms is generally well marked, and the condition known as the "brown striæ of Retzius" is also present. In severe cases the enamel in parts appears as a homogeneous brown mass. The dentine is seen to contain a large number of interglobular spaces, and in those teeth where the cause has acted intermittently these spaces will be found

FIG. 145.[1]

arranged in rows taking an upward and inward direction and corresponding to the pits or rows upon the enamel (see fig. 146).

J. E. Grevers of Amsterdam has pointed out that in some cases

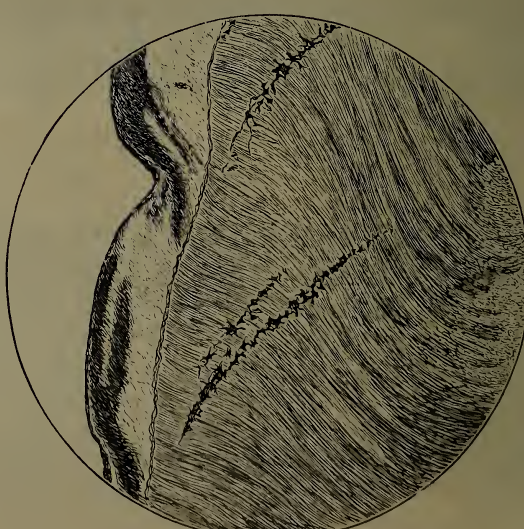

FIG. 146.

[1] From *Trans. Odonto. Soc.*

the defect visible on the surface is continued through the whole thickness of enamel.

Frequency of Hypoplastic Teeth.—These defective teeth are mostly met with in the lower classes. Sidney Spokes[1] found that out of 258 boys in one of the Public Schools 4·6 per cent. had hypoplastic teeth, whilst out of 1,463 boys and girls belonging to a Poor Law school the number affected was over 7 per cent., and out of 183 from a Poor Law Ophthalmic School the figures reached about 15 per cent. In these figures, enamel defects of the incisors and molars were alone included. Out of 250 infants there were fifteen cases of hypoplasia.

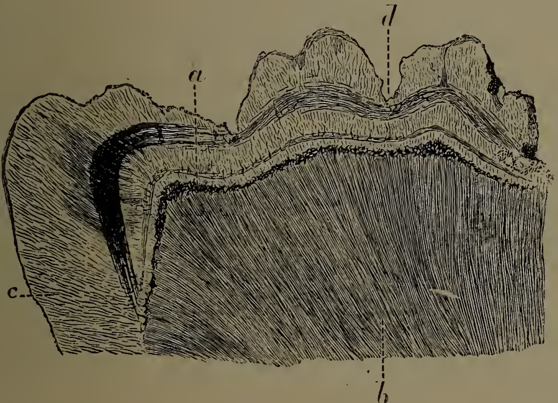

Fig. 147.—Section through a hypoplastic molar. *a*, interglobular spaces; *b*, dentine; *c*, enamel; *d*, a pit upon the masticating surface.

Etiology.—In looking for the cause of the deformity it must be remembered that the period at which the deformed enamel was being calcified must synchronize with the activity of the supposed cause. In most cases the malformation is on the crowns of the central incisors, the laterals, the canines and the first molars. This points to a cause acting during the first two years of life. Jonathan Hutchinson attributes the deformity to a stomatitis arising from the use of mercury. It will frequently be found on inquiry that patients with hypoplastic teeth were given mercury for convulsions, &c., during teething, or some form of teething powders containing mercury was used. On the other hand it should be remembered that many patients come under notice to whom no teething powders have been administered, but the hypoplastic teeth are nevertheless

[1] *Journ. Brit. Dent. Assoc.*, 1897, p. 31.

present; and, still further, cases are seen where teething powders containing mercury were freely administered during the process of teething without apparent effect upon the structure of the teeth.

An interesting case of a boy, aged $3\frac{1}{2}$, suffering from well-marked stomatitis due to the administration of mercury came under my notice at the Dental Hospital of London. At that age calcification is taking place in the premolars, but those teeth subsequently erupted with perfectly formed enamel. In this instance the stomatitis did not lead to hypoplastic teeth, and indeed there seems to be little evidence for the association of mercurial stomatitis with hypoplastic teeth as cause and effect.

It has been asserted that the epileptiform convulsions which are associated with hypoplastic teeth during infancy cause the tooth deformity, while others blame the mercury which is administered to cure the convulsions. But these explanations are not satisfactory, and in this connection the following case is of interest. A patient had three attacks of convulsions during teething. No mercury was administered. The enamel of the patient's teeth was slightly deformed. The other members of the family had no convulsions, but nevertheless teething powders were freely administered. Their teeth remained normal. This case tends to show an association between convulsions and defective tooth development, but there is nothing to fix the relationship as cause and effect, and it seems more rational to regard both as the effects of a common cause.

Kingston Barton, who has given much attention to this question and has kept careful records, states that in 202 children he found 10 cases of hypoplasia in the permanent and 5 cases in the deciduous series, the latter cases being restricted to hand-fed children, of whom there were 67. Out of the 202 cases, 54 were fully breast-fed, and in these no hypoplasia was present. He also adds that in two cases of very bad artificial feeding very early and extensive caries occurred.

During recent years there has been an awakening interest in the subject of infant feeding which has led to a diminution in the use of patent farinaceous foods, and coincident with the withdrawal of those foods a marked reduction has been observed in the number of children suffering from hypoplasia of the teeth.

Lamellar cataract is usually associated with hypoplastic teeth. N. G. Bennett[1] found the tooth abnormality associated with 22 out of 26 cases of lamellar cataract, and in 12 of the cases the defect

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[1] *Trans. Ophthal. Soc.*, vol. xxi.

in the molars extended up to or within an eighth of an inch of the gum margin.

Hypoplasia characterized by a single horizontal band of defective tissue can usually be traced to one of the specific fevers, although exanthemata occurring during infancy will not in every case affect the teeth. The facts which point to the exanthemata being the active cause in some cases are, briefly (1) that in children who have had one of the eruptive fevers during infancy, but who are otherwise healthy, distinct structural defects are sometimes present; and (2) that the period during which the defective portion of the tooth was calcifying synchronizes with the attack of the fever. Measles seems to produce the deformity most frequently, and, next after measles, scarlet fever. Each separate fever might be expected to produce characteristic results, but this does not seem to be the case, as no special class of deformity can with certainty be said to be associated with a particular fever, it being apparently impossible to determine with any certainty which fever has been the cause of the deformity. In support of this statement the following case may be instanced. A. D., when 2 years old, had an attack of scarlet fever, followed at a short interval by an attack of measles. The attacks were only slight and little or no effect could be detected on the labial surfaces of the incisors, but on the lingual surfaces of both the centrals and laterals, rather more than half-way up, two slight rings appeared. Both rings were precisely similar in appearance, and were no doubt the result of the two different attacks of fever.

Reference may here be made to a condition termed "Mottled teeth,"[1] which has been fully described by F. S. McKay and G. V. Black. The defect of the enamel consists of "minute white flecks or yellow or brown spots or areas, scattered irregularly or streaked over the surface of the tooth, or it may be a condition in which the entire tooth surface is of a dead paper-white like the colour of a china dish. In many cases the surface of the tooth is dotted with irregular, shallow pits, which are usually darkly discoloured because of the lodgment of débris. Any or all of the teeth may be mottled or certain groups only; or the area of some teeth either above or below a certain point may be mottled, and the rest of the enamel of such teeth be practically normal."

The essential malformation is a failure of the cementing substance between the enamel rods on the outer one-fourth to one-third of the surface of the enamel. In about 40 per cent. of the

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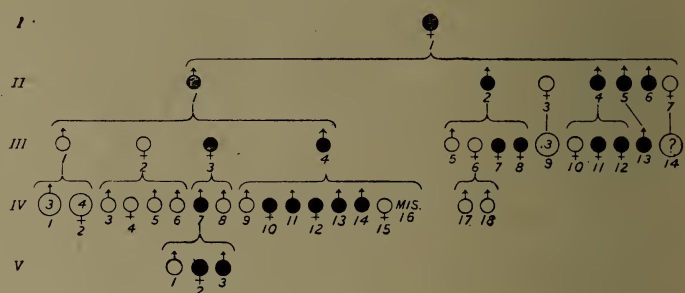
[1] *Dental Cosmos*, February and May, 1916.

cases a colouring matter—named by Black " brownin "—is formed in place of the cementing substance. This discoloration is not present when the teeth erupt, but gradually makes its appearance and is usually located on the labial aspects of the anterior maxillary teeth.

This hypoplasia of the enamel was met with in certain well-defined areas in the Rocky Mountains, and occurred only in those individuals who were born in any of these areas or who had lived there continuously during the period of enamel formation.

Examinations have been made of the water in the affected areas to discover a possible cause, but the results of the analysis were of a negative character.

Piergili[1] states that quantitative analysis has revealed a common characteristic in the waters of the regions wherein this



● indicates an affected person.
O indicates an unaffected person.

A large circle indicates a childship. The figure inside indicates the number of children. Where sex is known it is added.

FIG. 148.[2] (Turner.)

dental lesion is endemic; a minimum content of mineral salts in general, and of the salts of calcium in particular. This minimum content of calcium salts is the cause of the condition which produces mottled teeth. Chemically, water with its dissolved carbon dioxide has affinity for calcium carbonate. Unless this affinity be satisfied before the water be taken into the mouth, it will (unless the teeth have reached a certain maturity of hardness) dissolve out from the teeth this latter salt.

Hereditary hypoplasia of the teeth is a rare condition. In one

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[1] *La Stomatologie,* March, 1918.
[2] From *Trans. Odonto. Soc.*

case recorded by S. Spokes[1] the teeth were of a dark brown colour. There were grooves in the long axis of the tooth, and in some places there was a total absence of enamel, while in other places the enamel was present in irregular patches. The family history of

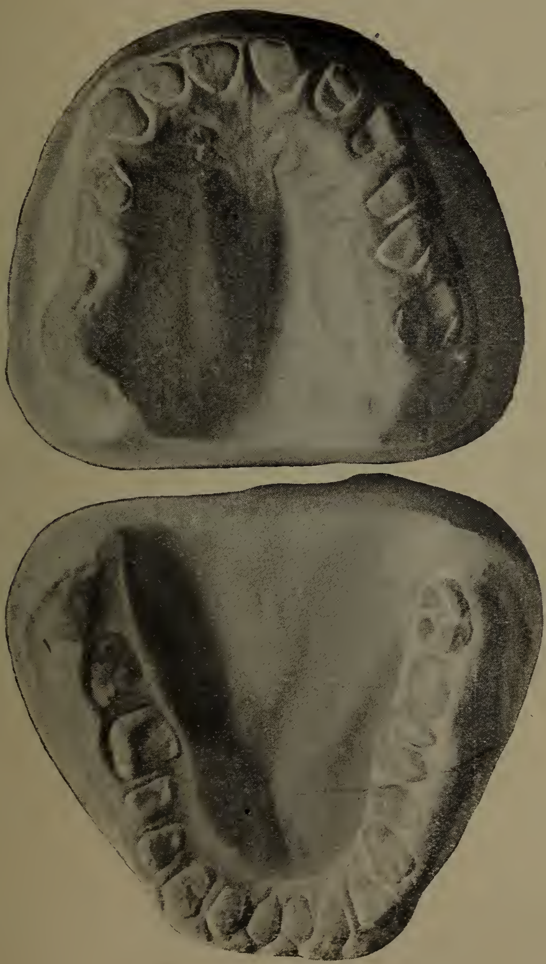

Fig. 149.[2]

the patient revealed the fact that a similar condition existed in many of the members and that both the deciduous and permanent dentitions were affected. The character of the teeth was examined

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[1] *Trans. Odonto. Soc.*, June, 1890, p. 229.

[2] From the Royal Dental Hospital Reports, 1910.

in forty-two individuals extending over four generations, of whom twenty-three had defective enamel.

An excellent account of a family exhibiting this hereditary hypoplasia of enamel was recorded by J. G. Turner,[1] who was able to trace the defect through five generations. Of the fifty individuals composing the table, twenty-one showed the abnormality (fig. 148). The abnormal condition was always transmitted through abnormals. The defect took the form of a stunting of the teeth accompanied by marked defect of the enamel, both the deciduous and the permanent dentitions being affected. Models of a patient showing this type of hypoplasia are shown in fig. 149.

(B) DEFECTS DUE TO LOCAL CAUSES

Defects in tooth structure may, in rare instances, be produced by local causes. The malformation is usually limited to a single tooth and may take the form of a pit, ring, or patch, or it may extend to the total absence of enamel. The premolars are usually affected, and S. Spokes finds that the condition is more frequently seen in the mandibular premolars and in the second more than in the first. In one case of local defect which came under notice, the distal half of the maxillary left canine was covered with small pits, the mesial half being quite normal (see diagram, fig. 150). In

Fig. 150.

another instance a patient had a distinct line of pits half-way down the right lower central, and the mother recalled the fact that the child had sustained a severe blow which injured the deciduous predecessor and led to its early loss. (See also chapter on Injuries of the Teeth.)

In many cases a single premolar is affected and distinct evidence of suppuration in connection with the deciduous predecessor can be obtained.

[1] *Trans. Odonto. Soc.*, vol. xxxix, p. 137.

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CHAPTER V

Abnormalities in Position of the Teeth.

General Considerations—Etiology

(A) GENERAL CONSIDERATIONS

(1) THE NORMAL ARRANGEMENT OF THE TEETH

Before discussing the abnormal positions in which teeth are found it is necessary to determine what is to be regarded as their normal position.

(*a*) **The Deciduous Teeth.**—If the mouth of a well-developed child of the age of five be examined, it will be noticed that the maxillary and mandibular teeth are arranged in arches with regular curves. The arch formed by the maxillary teeth is greater than that formed by the mandibular teeth, so that, on occlusion, the maxillary teeth overlap the mandibular teeth. On a more detailed examination of the arrangement of the teeth it will be observed that the maxillary central and lateral incisors overlap the mandibular central and lateral incisors in addition to the anterior half of the canine; the maxillary canine overlaps the posterior aspect of the mandibular canine and the anterior third of the first deciduous molar; the maxillary first molar occludes with the posterior two-thirds of the mandibular first molar and the anterior third of the second molar; the second maxillary molar occludes with the posterior two-thirds of the second mandibular molar and projects a little beyond this tooth (fig. 9).

(*β*) **The Permanent Teeth.**—The arch formed by the permanent teeth varies considerably, and especially in different races. In the English race the usual arrangement is as follows: The canines and incisors form the arc of a circle; the premolars, first and second molars pass back from the canines in straight lines diverging slightly outwards; the third molar is placed a little internal to the arch. Variations from this arrangement are not uncommon; for example, the premolars and molars may be arranged on a well-marked curve or in a perfectly straight line diverging outwards only very slightly.

The arch formed by the upper teeth is greater than that formed by the lower. The upper central and lateral incisors overlap the lower central and lateral incisors in addition to the anterior half of the canine; the upper canine overlaps the distal half of the canine and the anterior half of the lower first premolar; the first upper premolar occludes with the posterior aspect of the first lower premolar

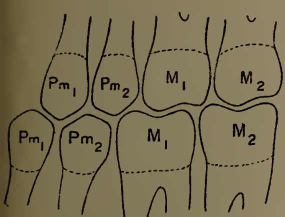

Fig. 151.[1]

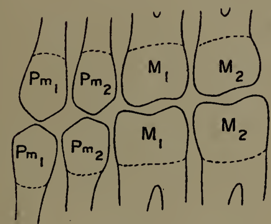

Fig. 152.[1]

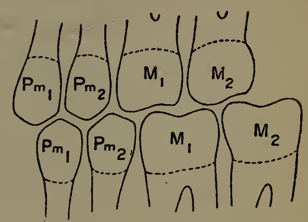

Fig. 153.[1]

In referring to the occlusion of the teeth, the following notation will be adopted :—

N, to indicate that the occlusion of the teeth is normal, fig. 151.

X, to indicate that the mesial surfaces of the molars or premolars are flush, fig. 152.

O, to indicate that in occlusion the mesial aspects of the maxillary molars or premolars are in advance of the mandibular, fig. 153.

and the anterior aspect of the second premolar; the upper second premolar occludes with the posterior half of the second lower premolar and the anterior third of the first lower molar; the upper first molar occludes with the posterior two-thirds of the lower first molar and the anterior third of the second molar; the second upper molar occludes with the posterior two-thirds of the second lower molar and the anterior third of the third molar; the upper third molar meets the posterior two-thirds of the lower third molar.

Any deviation from the arrangement described above must be regarded as abnormal, but before dealing with circumstances which are responsible for the production of irregularities it is necessary to review briefly certain points in connection with the development and growth of the jaws and arches.

(2) THE DEVELOPMENT AND GROWTH OF THE JAWS

The maxilla, formed from the maxillary process, arises as a membrane bone external to the cartilaginous nasal capsule and

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[1] From *Proc. Roy. Soc. Med.*

in the neighbourhood of the canine tooth germ by one centre of ossification. From this centre three processes rapidly radiate:—

(i) A nasal process which grows upwards.

(ii) An alveolar process which grows downwards, is thickened at its root to form the malar process, and might be called the alveolo-malar process.

(iii) A palatine process which grows inwards.

The premaxilla is formed from the meso-nasal process and fuses with the maxilla about the third month, the maxilla overlapping and almost excluding it from the face.

The mandible is developed in membrane as a single element, and its growth is determined to a great extent by that of the maxilla. At birth, the mandible consists of two halves joined by fibro-cartilage, and at about the sixth month the two segments unite. It is possible that the segments grow to some extent before they unite.

In the **maxilla** at birth, the tooth germs lie in close proximity to the orbital plate, the antrum being represented by a slight depression internal to and just above the follicle of the second deciduous molar. The crypts of the incisors and canines are complete, but between the first and second molars the septum is still imperfect. The lateral incisor lies slightly posterior to the central incisor, and the crypt of the first molar is in close proximity to it, the canine lying between and anterior. As the time for the eruption of the incisors approaches, the space between the lateral incisor and the first molar increases, the growth of bone at this point continuing until the eruption of the canine. There is reason to suppose that room is made in the arch for the canine by growth of bone at the suture between the premaxilla and the maxilla.[1] With the eruption of the second molars the deciduous dentition is complete. An examination of the mouth at this stage will show an interval between the first molar and the end of the alveolar ridge. This interval increases in size until the advent of the first permanent molar. A skull examined at this period, namely, about six years of age, would show the following condition: In the **maxilla** the lateral incisors are placed slightly posterior to the central incisors and are directed more vertically. The premolars are embraced by the roots of the deciduous molars and their crowns are directed inwards, the second more than the first. The first premolar is normally situated close to the lateral incisor. The

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[1] See paper on "Abnormalities in Position of the Teeth in Man," *Dental Record*, February, 1914.

canine lies above and external to the arch of the incisors and premolars and is directed slightly outwards. The first permanent molar will be in the process of erupting and the occluding surface will be directed outwards to a slight extent. The second permanent molar is situated high up in the tuberosity of the bone, with its occluding surface directed downwards, outwards and well backwards. In **the mandible** the lateral incisors lie in a plane posterior to the centrals and the canines are placed near the lower border of the bone and lie in a plane anterior to the lateral incisors with a slight tilt towards the median line. The premolars are embraced by the roots of the deciduous molars and their crowns are directed inwards. The first permanent molars are directed upwards and forwards, the second being under the base of the coronoid process with the occluding surface directed upwards, forwards and slightly inwards.

In order that a regular arch may develop from this somewhat chaotic arrangement of the teeth it is necessary that the growth of the jaw should continue without interference. Let us consider first of all the replacement of the deciduous teeth by their permanent successors. The first change noticeable is the gradual spacing of the deciduous incisors for some time before the advent of the permanent teeth. This spacing is usually regarded as a "translation forward of the teeth," the necessary space for the greater breadth of the permanent teeth being obtained, it is said, because the permanent teeth, in consequence of the "translation," occupy the arc of a larger circle. It seems possible, however, that, as pointed out above, a growth of bone does take place in the suture between the premaxilla and the maxilla.

The permanent canine is larger than the deciduous canine, but the premolars are smaller than the deciduous molars, the increased size in the case of the permanent canine being counterbalanced by the decreased size in the case of the premolars. The growth of the maxilla backwards provides room for the permanent molars. The growth of the maxilla has been shown by Keith[1] to be dependent on the expansion of the maxillary antrum. At birth the antrum consists of a slight depression just above the follicle of the second deciduous molar. This depression spreads towards the orbital plate, and, at the end of the first year, has developed forwards over the first deciduous molar and backwards over the

[1] "The Expansion of the Maxillary Antrum," A. Keith, *Brit. Journ. Dent. Sci.*, June 16, 1902.

first permanent molar, an extension of the sinus rapidly taking place as the remaining molars are formed.

The effect of the growth of the antrum on the eruption of the teeth can be studied by examining the relation of the teeth to the antrum in a sixth-year skull. The first permanent molar lies in close relationship to the sinus, with the occluding surfaces looking downwards and backwards. "As the tooth moves into position, it rotates so as to bring its crown downwards and backwards, while the sinus spreads downwards and backwards between the roots of the teeth. The growth of the antrum wheels, as it were, the tooth

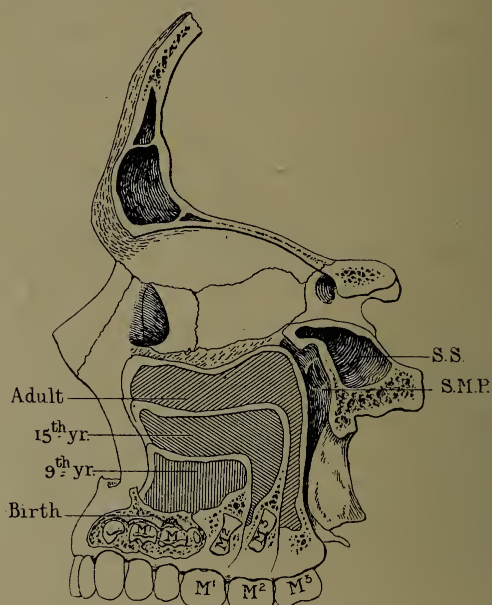

Fig. 154.—The above drawing by Arthur Keith illustrates the position of the developing molars and the relation of the maxilla to the pterygoid processes. "The diagram is drawn to scale and is founded on material in the museums of the Royal College of Surgeons and of the London Hospital. Four stages are shown (1) at birth, (2) at the 9th year, (3) at 15th year, and (4) in the adult. . . . While the diagram demonstrates clearly the growth changes which occur in the jaw, it must not be forgotten that, in the body, the postero-superior border of the sinus is the fixed, and not the moving point as represented in the diagram."

into position. An exactly similar condition occurs with the second and third molars."

"The fulcrum on which this rotation of the bone takes place is formed by the body of the sphenoid, the anterior surface of its great wing, and the pterygoid plates, mainly the internal." (See fig. 154.)

In the mandible the replacement of the deciduous teeth by the permanent teeth takes place in a manner similar to that in the maxilla, the space for the molars being obtained by a backward growth of the bone, the growth being correlated with the growth of the maxilla consequent on the expansion of the antrum. A recognition of this phenomenon is necessary in studying the pathology of certain types of irregularities of the teeth.

"*The normal orderly arrangement of the teeth in the jaws is the result of normal growth of the bone.* The teeth may react on the bone, but the main factor in the translation of the teeth to their normal position in the arch is the work of the growing bone. In other words, the arrangement of the teeth in a normal arch is not necessarily dependent on want of room in that arch."[1] (Further reference will be made to this point in dealing with adenoids.)

(3) FACTORS INFLUENCING THE GROWTH OF THE JAWS

Functional activity influences the growth of the jaws and may be conveniently dealt with under the following heads:—

(α) The influence of mastication.
(β) The function of the teeth.
(γ) The action of the tongue.
(δ) The nasal function.

It may here perhaps be pointed out that the proper function of a part is necessary for the due growth of that part, as instanced by the mal-development of the orbit which follows the loss of an eye in youth.

(α) **The Influence of Mastication.**—In considering the influence of mastication on the jaws a brief reference must be made to the relation of the muscles to the bones. Fig. 155 is a vertical transverse (slightly oblique) section through the head on a level with the epiglottis, showing the massiveness of the masticating muscles. Fig. 156 is a horizontal transverse section about an inch below the condyles of the mandible, showing the outward direction of the external pterygoids as well as the close relation of the levatores and tensores palati with the internal pterygoids. From these figures it will be seen that " the pterygoids, when in a state of contraction, must exercise an outward and backward tug on the external pterygoid plate, palate bone, body of the sphenoid and maxilla, and tend to pull them away from the sagittal plane of the head."

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[1] J. G. Turner, "The Influence of the Growth of Bone in the Arrangement of the Teeth," *Dental Cosmos*, vol. xlvii, p. 43.

Harry Campbell is of the opinion that, in addition to the actual mechanical action of the pterygoid muscles, their rhythmic contraction greatly aids the circulation of the blood and lymph and so exercises a beneficial effect on the structures in the immediate neighbourhood. Races that live on coarse food requiring abundant mastication invariably have well-developed jaws. Anything, therefore, which tends to diminish the use of the masticatory muscles adversely influences the growth of the jaws.

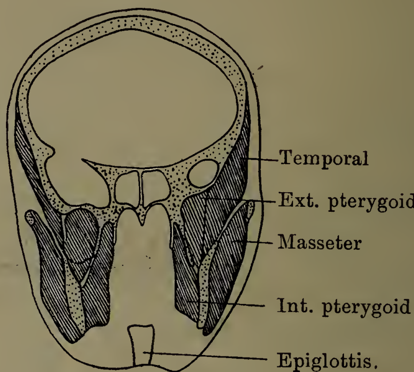

FIG. 155.[1]

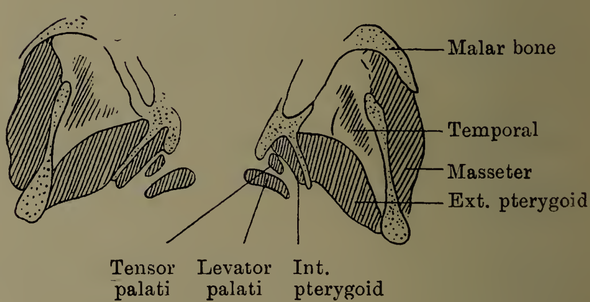

FIG. 156.[1]

(β) **The Teeth.**—The positions occupied by the teeth influence the growth of the jaws. The teeth transmit the force of muscular action to the bones. Normally the maxillary teeth are arranged with the occluding surfaces of the premolars and molars facing

[1] Copied from the *Trans. Odonto. Soc.*, by kind permission of Harry Campbell.

slightly outwards, and the force applied to them in this position in mastication has a general tendency to expand the jaws. The more vertical the direction of the teeth the less will be the influence of muscular pressure towards increasing the width of the maxillæ.

(γ) **The Action of the Tongue.**—The tongue influences the position occupied by the teeth in the arch. Sim Wallace[1] considers that the tongue is the common denominator for the correlation of the upper and lower teeth, and he is of opinion that there is an intimate connection between the size and growth of the tongue and the size and development of the jaws. A large tongue, by causing the teeth to occupy a large arch, stimulates the outward growth of the jaws. The pressure of the tongue on the anterior part of the palate during the act of swallowing is probably an important factor in modifying this part of the mouth. In Wallace's opinion the under-development of the tongue and the decreased size of the jaws at the present day are to be attributed to the slight amount of mastication which is now necessary in the consumption of food.

(δ) **The Nasal Function.**—The perfect performance of nasal respiration is an important factor in the growth of the maxilla. The use of the muscles of the nose influences the growth of the premaxilla and the constant flow of air through the nasal passage stimulates the supply of blood to the mucous membrane lining the nasal fossa and the accessory sinuses and so stimulates the general growth of the bone.

(B) ETIOLOGY.

Adami, in his excellent work on Pathology,[2] makes some valuable general remarks in the introduction to the section on Causes of Disease, and these remarks may with advantage be quoted here because they will render more intelligible to the reader the account to be given of the causes producing irregularities in the position of the teeth. He states that "Every departure from the normal, whether in the cell, the organ, or the system in general, is a pathological condition, provided that we recognize that the 'normal' is not an absolutely fixed point, but is the expression for the limits between which the majority of the individuals of a given species will be found to group themselves as regards any particular attribute. Such pathological conditions must, it will be

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[1] A lucid account of Sim Wallace's views is to be found in his work on "Irregularities of the Teeth."

[2] "The Principles of Pathology," by J. G. Adami.

seen, be of two orders: either primarily due to some constitutional defect transmitted from the parent or parents (included with which we must place the effects of imperfections in the fusion of the male and female elements at the moment of fertilization. Such effects, being associated with the actual constitution of the individual, are of internal origin and inherited); or, in the second place, they may be the result of some influence which first affects the individual after his genesis. Such conditions are of external origin and acquired. Morbid conditions, then, are to be classified into inherited and acquired."

It is advisable to make quite clear what is understood by the term inherited as here used. To quote Adami, "That alone is inherited which is the property of the individual at the moment of his becoming an individual, which is part and parcel of the paternal and maternal 'germ plasm' from which he originates, or is provided by the interaction of the same." "It is unnecessary to point out, save as a precaution, that what is a property of the individual from the moment of beginning existence need not show itself for long years—a family failing towards premature baldness not until years after puberty, or an inheritance of gouty tendencies not until after thirty-five. As the different organs and parts assume their particular conformation and properties at different periods, and do not develop *pari passu*, so must the various inherited peculiarities make their appearance at various times."

The classification based on these principles and adopted by Adami is as follows:—

(1) Inherited, due to influences affecting the ovum or the spermatozoon before or at the moment of fertilization.

(2) Acquired.

- (*a*) Ante-natal or of intra-uterine acquirement.
- (*b*) Parturient, acquired at the time of birth before complete separation of the individual from the maternal organism.
- (*c*) Post-natal, acquired after birth.

There are objections to the application of this scheme to irregularities of the teeth. For example, it is often impossible to say with certainty whether a particular condition is due to an inborn predisposition or to an extrinsic stimulus; thus cases of cleft palate may be markedly hereditary, or, on the other hand, may be distinctly traceable to defective nurture. From a biological point of view, however, the scheme has the great advantage of being based on endogenous causes (variations) and exogenous causes (modifications), and it is proposed to adopt this classification in describing the various abnormalities in the position of the teeth.

(1) ABNORMALITIES DUE TO INHERITED CAUSES

(a) *Abnormalities due to Reduplication of Organs—Meristic Excess*

Irregularities due to the presence of supernumerary teeth will be included in this group.

Supernumerary teeth may be present in the arch, in addition to the normal number of teeth, and cause a generally irregular arrangement of the teeth. An example is seen in fig. 157. The supernumerary tooth or teeth may erupt in the arch and cause perverted growth and non-eruption of the normal teeth. Thus

Fig. 157.—Maxillæ with two supernumerary teeth causing irregularity of the central incisors.

fig. 158 shows the right maxillary incisor placed high up in the alveolar process, with its root considerably curved, and in fig. 159 two supernumerary teeth occupy the position of the maxillary central incisor, one of which is displaced and considerably contorted. The other incisor, which is missing, may have been removed before death.

(β) *Abnormalities arising from Defects of the Tooth Band*

The irregularities included in this group would seem to be due to the tooth bud being given off in an abnormal position.

Cases of extreme displacement of teeth occurring in otherwise normally developed arches should perhaps be grouped under this heading.

(i) *The Maxillary Canine.*—Developmental irregularities in the position of this tooth are common, and vary from a slight deviation from the normal to complete inversion of the tooth and eruption

Fig. 158.—Maxillæ with the right central incisor embedded in the bone. A supernumerary tooth is present in the arch.

Fig. 159.—Portion of maxillæ with two supernumerary teeth erupted in the arch. The left central incisor is displaced.

into the nasal fossa. The following specimens show a progressive degree of irregularity:—

In fig. 160 the canine has erupted internal to the arch and caused slight irregularity in the position of the lateral incisor. In fig. 161 the left canine has erupted in a vertical position internal to the arch, while the right canine has assumed an oblique direction,

the crown lying in the palate behind the central and lateral incisors and the root being embedded in the bone in close contact with the roots of the premolars. In fig. 162 the canine has entwined itself around the alveolar process, the crown projecting in the palate and the root appearing just under the outer alveolar plate. A further

Fig. 160.—Maxillæ with the left canine erupting internal to the arch.

Fig. 161.—Maxillæ showing misplaced canines.

stage is marked by the misplaced tooth lying external to the dental arch in a horizontal position, as seen in fig. 163. Next the tooth takes an upward turn, as seen in fig. 164, piercing the gum high up on the alveolar process; while in the final stage there is complete inversion, as in fig. 165. In the last specimen the condition is symmetrical; both teeth are embedded in the nasal process of the

maxillary bones. In the specimen shown in fig. 166 the tooth has worked its way into the nasal fossa.

The positions assumed by the canine in cases of this kind undoubtedly follow a definite law, and the discovery of that law

Fig. 162.—The left canine is lying horizontally across the alveolar process.

Fig. 163.—Portions of the maxillæ showing the canines lying in a horizontal direction with the crowns directed towards the median line.

would mean a great advance in our knowledge of the cause of these irregularities.

(*a*) The canine in many animals is a tooth of sexual warfare.

(*b*) The irregularity is not confined to the highly civilized races of man, although it is much more common in such races.

FIG. 164.—Left maxilla with the canine erupting in an upward direction.

FIG. 165.—Skull showing the canines embedded in the nasal processes.

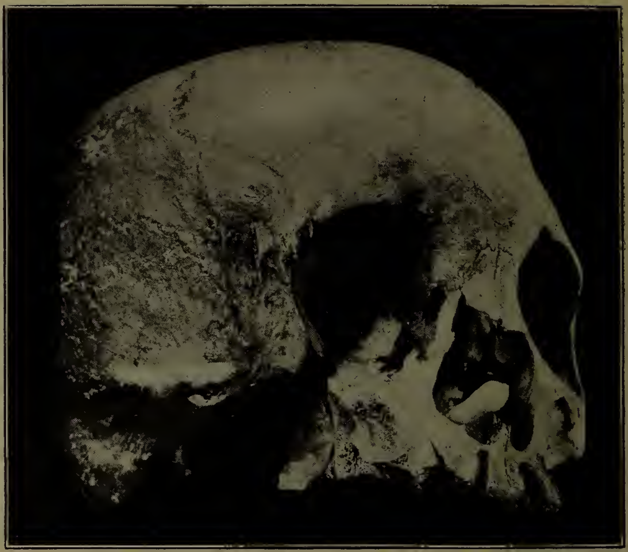

FIG. 166.—Skull of a negress with the right canine erupting in the nasal fossa. This specimen is in the Hunterian Collection.

FIG. 167.—Right maxilla with the first premolar erupting in the palate.

(*c*) The irregularity would appear to be more often met with in the well-to-do classes than in those less favourably placed.

(*d*) The irregularity is more commonly seen in the female than in the male.

(*e*) The left canine is more commonly misplaced than the right canine.

(ii) *The Maxillary Premolar.*—Complete displacement of the premolar is comparatively a rare irregularity. An example is shown in fig. 167, and another in fig. 168. In the latter specimen the second deciduous molar persists and is free from sepsis.

Fig. 168.—Model showing the second premolar misplaced external to the arch.

The complete displacement of a premolar is more common in monkeys than in man, and a study of the irregularity in these animals enables us to formulate a probable explanation of the cause. If the relation of the developing premolar to the deciduous molar is examined in monkeys it will be noted that it is the rule for the premolar to be developed well above the root of the deciduous molar (see fig. 169). It is easy to realize, therefore, that the slightest deviation of the developing tooth from the normal direction might cause it to be displaced. The irregularity in man can possibly be explained on similar lines; that is to say, the premolar, instead of developing within the roots of its predecessor, is formed beyond

them, and has therefore a tendency to assume an abnormal position in its subsequent growth.

(iii) *The Maxillary Molars.*—The third maxillary molar is frequently misplaced. This tooth may be carried away from the

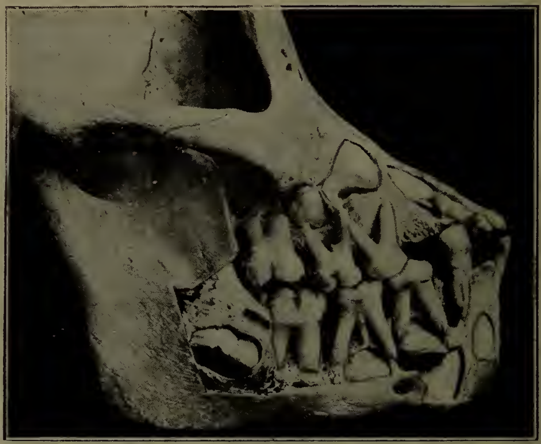

Fig. 169.—The skull of a chimpanzee to show the position of the developing second premolars.

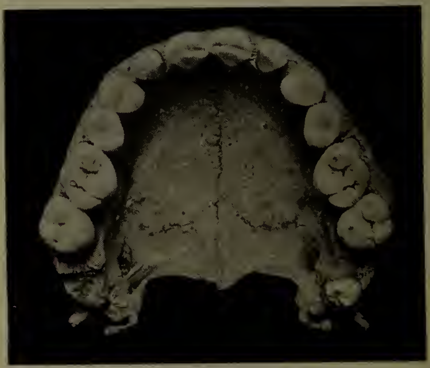

Fig. 170.—Maxillæ with the left third molar displaced backwards.

second molar (see fig. 170), but more often it is situated high in the tuberosity and, as growth proceeds, becomes embraced by the roots of the second molar. At times the tooth develops so high above the second molar that fusion of the roots may take place.

Lastly, we get that singular condition in which the crown of the third molar lies in an inverted position within the roots of the second molar (fig. 171).

Fig. 171.[1]

A curious but well-defined class of irregularity is shown in fig. 172. The maxillary premolars and the first and second molars on the right side have erupted external to the arch of the lower teeth. This irregularity did not exist in the deciduous dentition,

Fig. 172.—Models of a female at fourteen years, showing the premaxillary premolars and molars external to the arch of the mandibular teeth.

and the first sign of it was the eruption of the right maxillary first molar in the position shown in fig. 173. A similar condition is occasionally seen in the apes and monkeys.

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[1] From "A System of Dental Surgery," by C. S. Tomes and W. S. Nowell.

The explanation of these cases is probably to be found in an aberration of the portion of the tooth band from which the teeth have their origin.

Fig. 173.—Models of the same individual taken at about seven years of age to show the occlusion of the deciduous teeth.

A remarkable specimen showing irregularity in position of several teeth is shown in fig. 174. The maxillæ and the rest of

Fig. 174.—Portion of a skull showing multiple irregularities in position of the teeth.

the skull are normal in character, but the teeth show an extraordinary arrangement. On one side the canine has erupted between the premolars, with the root of the deciduous canine persistent in

its normal position. On the right side the canine lies obliquely across the alveolar ridge, the crown pointing forwards and slightly outwards and downwards, with the root running backwards,

Fig. 175.—Mandible with the left lateral incisor rotated.

slightly inwards and upwards. The whole tooth is rotated so that the internal aspect of the crown is downwards. The premolars are missing, and there are no signs that they were ever present. The

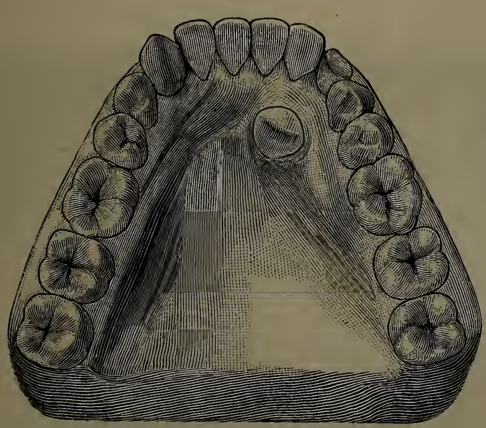

Fig. 176.—Model showing the mandibular right canine placed internal to the arch.

first molar lies horizontally, with the occlusal surface directly backwards and the roots forwards. It is of interest to note that there are two enamel nodules on the left second molar.

(iv) *Mandibular Incisors.*—In well-developed arches the lateral

incisor is at times rotated so that the distal angle looks inwards. This irregularity should be classed as a definite inherited defect. A mandible showing this irregularity is illustrated in fig. 175, and it is interesting to note that the developing second molar is also misplaced (see fig. 181).

Fig. 177.—Mandible with the right canine erupting anterior to the roots of the incisors.

(v) *Mandibular Canines.*—Although not so prone to wander as its fellow maxillary tooth, the mandibular canine shows definite variations in its position. It may erupt internal to the arch

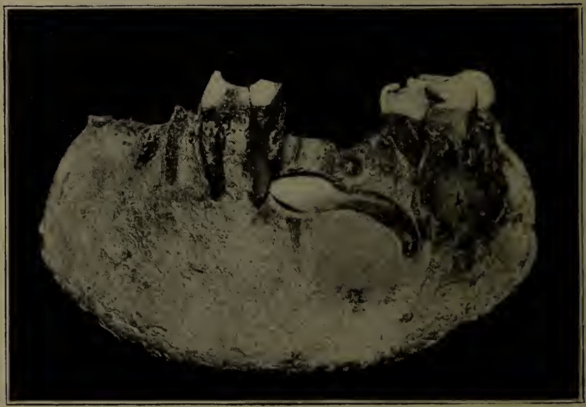

Fig. 178.—Portion of mandible with the left canine embedded in the bone.

(fig. 176), or it may appear external to the arch directly in front of the incisors (fig. 177), while in other instances it may remain embedded in the bone, as in fig. 178.

(vi) *Mandibular Premolars.*—These teeth are at times completely displaced. In the specimen shown in fig. 179 the first premolar lies in a horizontal position embedded in the bone with the crown

FIG. 179.—Left half of mandible with the first premolar embedded in the bone.

pointing away from the mid-line. At times both second premolars may be embedded in the bone (fig. 180). The roots of the teeth,

FIG. 180.—Mandible with the second premolars embedded in the bone.

as will be seen from the illustration, are in close proximity to the lower border of the bone and there is no suspicion of the condition being due to impaction, as there is ample room in the arch. It is

quite possible that the abnormality is in some measure due to an aberration in the position of the tooth germ.

Fig. 181.—Mandible with the growing second permanent molars tilted directly inwards. This is a side view of the specimen shown in fig. 175.

Fig. 182.—Skull and mandible of a young ape, to show the position of the developing second permanent molars.

(vii) *Mandibular Molars.*—The curious inward tilt of the second molar, which in some instances amounts to the tooth occluding completely internal to the upper arch, should, it seems, be regarded as an inherited defect. Normally the second molar develops with

an inward tilt, but occasionally the development takes place with the occluding surface directly inwards (see fig. 181). This curious inward tilt of the growing second molar is frequently seen in the anthropoid apes (fig. 182).

FIG. 183.—Mandible showing slight tilting of the third molars.

Among the conditions which have to be treated in practice there are few which demand more thought and care than a misplaced third mandibular molar that is causing trouble. The tooth may

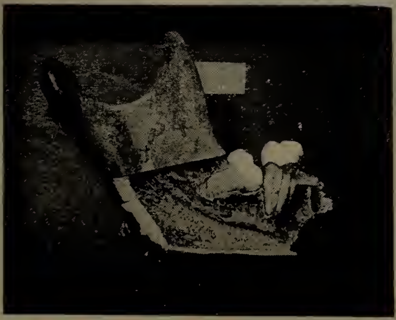

FIG. 184.[1]

be only slightly tilted forward (fig. 183); or it may be placed horizontally, the occluding surface of the crown impinging on the posterior root of the second molar (fig. 184). In some instances

[1] From *Trans. Odonto. Soc.*

the tooth may be so placed that the occluding surface faces downwards and inwards (fig. 185). An examination of specimens exhibiting the third mandibular molar misplaced will demonstrate very clearly that the roots are to a greater or less extent covered by the ascending ramus of the mandible. This is well shown in

Fig. 185.[1]

fig. 184. Other points brought out in this specimen are the close proximity of the root of the tooth to the mandibular canal, and the small amount of bone existing at the posterior aspect of the second molar.

Fig. 186.[1]

By far the most interesting specimen of misplaced third molars is that shown in fig. 186. The right third molar is situated in the centre of the upper part of the ramus. The tooth is placed vertically, the crown being but little below the sigmoid notch. The left third molar is also misplaced, and rests in the anterior portion

[1] From *Trans. Odonto. Soc.*

of the ramus. Both teeth, as might be expected, lie above the mandibular canal.

The specimen shown in fig. 187 seems to throw some light upon the foregoing pathological treasure. The specimen represents the mandible of a gorilla, in which two cone-shaped teeth are embedded in the right ramus; one of these teeth is triple-rooted and one single-rooted. The full number of premolars and molars are in place in the mandible, and the cone-shaped teeth must therefore be regarded as supernumerary teeth. It will also be noticed that they lie above the mandibular canal. In this case there has been

FIG. 187.[1]

an abnormal prolongation backwards of the "tooth band," and it is probable that the misplaced third molar is due to the same cause.

J. J. Andrew[2] has recorded a case in which the left mandibular third molar was misplaced high up in the right ramus, but with the apex towards the sigmoid notch (see fig. 188). In this patient, a woman aged about 55, suppuration had occurred in connection with the tooth, necessitating its removal. "An obtuse-angled incision was made along the posterior border of the ramus, and the angle of the jaw and the masseter temporarily displaced; the bone just below the sigmoid notch was removed by means of a trephine and the tooth exposed and removed."

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[1] From *Trans. Odonto. Soc.*

[2] *Brit. Dent. Journ.*, vol. xxx, p. 289.

Fig. 188.[1]—(1) Hard palate; (2) teeth and crowns in mandible; (3) sigmoid notch; (4) third molar; (5) sinus leading from mouth; (6) mandibular canal; (7) trachea.

[1] From *Brit. Dent. Journ.*

In the case shown in fig. 189 the third molar erupted at the angle of the jaw.

(γ) *Abnormalities due to Variation of Jaw Development in Relation to the Size of the Teeth*

" Individual variability is a general character of all common and widespread species of animals or plants; and, further, this variability extends, so far as we know, to every part and organ, whether external or internal, as well as to every mental faculty. Yet more important is the fact that each part or organ varies to a considerable extent independently of other parts " (Wallace).

Fig. 189.

In this section it is proposed to consider how far this phenomenon of variability is responsible for general irregularity of the teeth. If series of different species of animals be examined it will be readily observed that a diminution in lengths of the jaws is not associated with a corresponding diminution in the size of the teeth, with the result that in many species the teeth are arranged in a slightly irregular or crowded manner. In an extended investigation made of wild animals I have been surprised at the large number of skulls that show a slightly crowded arrangement of the teeth. In animals under domestication this variation in the length of jaw without corresponding adjustment in the size of the teeth is still more marked, particularly in the different breeds of dogs. It may be

said that as a rule the shorter the jaw, the greater the tendency to crowding of the teeth (see figs. 190-193).

Man is no exception to this law of variation, and with the pro-

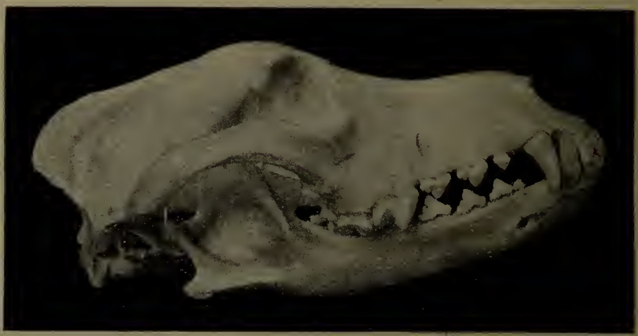

Fig. 190.—A long muzzled variety of dog.

Fig. 191.—Views of the dental arches of the specimen shown in fig. 190. The teeth are arranged in a regular manner with spaces between the premolars.

gress of civilization the reduction in the size of the jaw out of proportion to the reduction in the size of the teeth has been marked.

Talbot,[1] who has collected a large number of statistics relating to irregularities, states that the early Britons possessed maxillæ varying in their lateral diameters from 2·12 to 2·62 in., whilst in

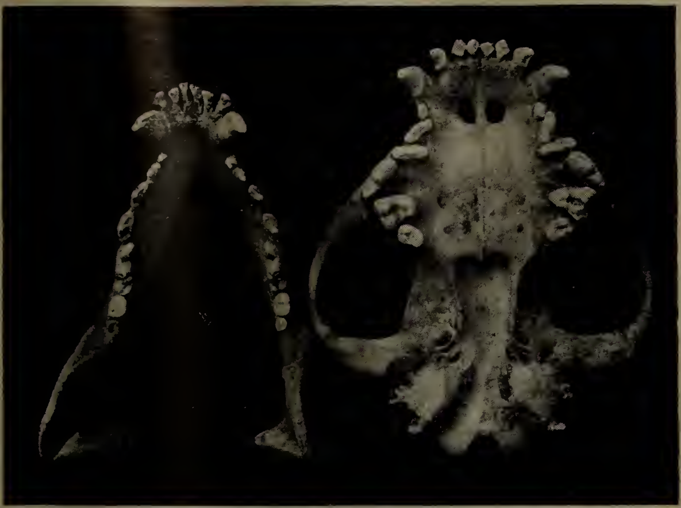

FIG. 192.—A short muzzled variety of dog.

FIG. 193.—Views of the palatal arches of the specimen shown in fig. 192. There is marked irregularity in the arrangement of the maxillary premolars and molars.

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[1] "The Etiology of Osseous Deformities of the Head, Face, Jaws, and Teeth," Third Edition, p. 67.

modern Englishmen the maxillæ vary from 1·88 to 2·44 in., the minimum diameter having thus decreased more than the maximum; and a comparison of the maxillæ of ancient Romans with modern inhabitants of Southern Italy gives a similar result. From these data he infers that a diminution in the size of the jaws has taken place in the inhabitants of England and Italy, but it is not quite clear that these comparisons of the maxillæ of ancient Britons and ourselves, and of ancient Romans and modern Italians, have any etiological significance seeing that modern Englishmen are only to a very small degree, if at all, descendants of the ancient Britons; and similarly, the present inhabitants of Southern Italy have but little claim to direct descent from the ancient Romans.

It is interesting to note that a diminution in the size of the teeth can be traced to prehistoric times. W. Wright[1] shows that the average molar length in Neolithic and Bronze Age jaws is greater than in those of the early Iron Age.

There is, however, a general consensus of opinion in favour of the view that the jaws and teeth of modern races are becoming smaller, the diminution in size being greater in the jaws than in the teeth.

The cause of the progressive diminution in the size of the jaws has not yet been clearly demonstrated, but, in view of all the ascertained facts bearing on the subject, the change would appear to be attributable in a great measure to the influence of civilization, and more particularly to diet and to the manner in which food is prepared. Sim Wallace, who has given considerable attention to the subject, considers that the diminution is not due to heredity, but is " a characteristic developed in each generation as the result of the action of the environment" i.e., insufficient mastication deprives the jaws of the stimulus necessary for their full development, the character of the food-stuffs of the present day being responsible for the insufficient mastication.

(δ) *Defects of the Maxillary Bones and Associated Parts.*

Under this heading are to be included irregularities in position of the teeth due to inherited defects in growth of the maxillary bones themselves or the soft tissues attached to them.

In this group is included the irregularity of the central incisors where the *frænum of the lip*, instead of blending with the muco-

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[1] *Journ. Brit. Dental Assoc.*, February 16, 1903.

periosteum on the anterior aspect of the alveolar process, is continued between the incisors and blends with the tissues in the region of the anterior palatine foramen. In these circumstances the frænum presses on the teeth with every movement of the lip and this pressure tends to separate the teeth. A persistent labial frænum of the lower lip occurs, but much less frequently. This irregularity is at times transmitted from parent to offspring.

(2) ABNORMALITIES DUE TO ACQUIRED CAUSES

(*a*) Ante-natal or Intra-uterine Acquirement

In cases of defective development of the maxilla or mandible the teeth present marked abnormalities of position. In cleft palate

Fig. 194.—Specimen showing arrested growth of the left half of the mandible.

involving the premaxilla the incisors and canine are misplaced, while partial arrest in the growth of the mandible naturally results in considerable disturbance of the relation of the dental arches to one another. A mandible showing arrest of growth of the left half is shown in fig. 194, and in fig. 195 the models of a case in which a similar condition was present.

It might seem more appropriate that irregularities associated

with defective development of the maxillary bones should be grouped under "inherited defects." It is, however, more in keeping with the general trend of current opinion to regard them as due to intra-uterine processes.

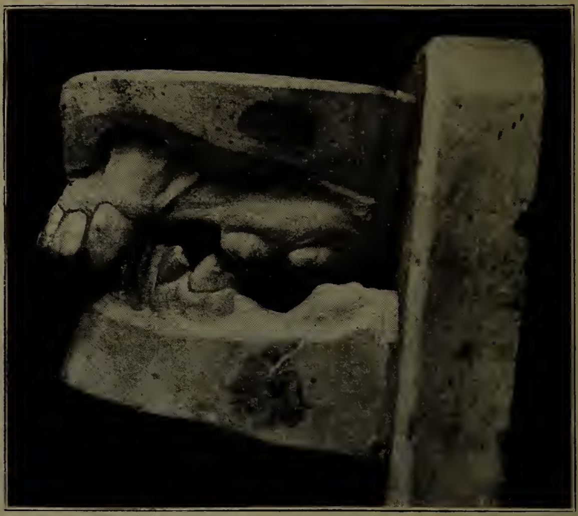

FIG. 195.—Models of a patient in which the left half of the mandible was arrested in its growth.

(β) PARTURIENT, ACQUIRED AT THE TIME OF BIRTH BEFORE COMPLETE SEPARATION OF THE INDIVIDUAL FROM THE MATERNAL ORGANISM

There is ground for believing that a few abnormalities of the teeth may be traced to injury at birth. Fig. 196 illustrates the case of a boy six years of age who came under the care of G. Berwick. The defective growth of the mandible, due to an injury at birth, resulted in marked prominence of the upper teeth. The labour was very difficult and it was necessary to use forceps, which injured the face on the right side from the angle of the jaws to the chin.

It seems quite possible that prolonged labour, especially in certain presentations, may lead to abnormality in position of the teeth.

The asymmetry of the dental arch so often seen is probably the effect of excessive moulding of the skull during birth. An example is shown in fig. 197. It will be noticed that the left side of the face is flattened and that the left occipital region is squeezed out-

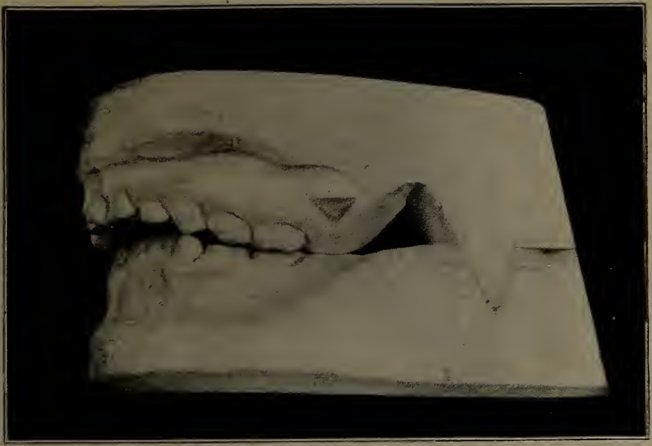

Fig. 196.—Models of a child, showing the results of injury of the mandible at birth.

wards. In this case the labour was prolonged but no instrument was used. According to the father's statement "the child was born with the head as it is, but the doctor said it would come straight in time."

Fig. 197.—Photograph of a child with extreme asymmetry of the face.

The asymmetry of the mandibular arch is shown in a drawing on mm. paper from a model of the mouth[1] (fig. 198).

The models shown in fig. 199 are those of a boy about five years of age. The parents are healthy, and possess normal jaws. The child was breast-fed and there was no suspicion of adenoids. The width of the arch is 22·76 mm. across the inter-canine region and

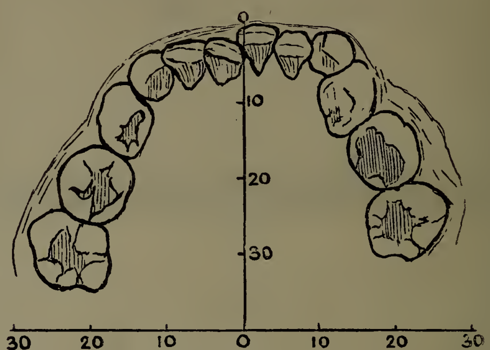

Fig. 198.—The mandibular teeth of the case shown in fig. 197.

Fig. 199.—Models showing abnormal occlusion of the teeth.

29·65 mm. across the second molar region. These dimensions are above the average. The occlusion is abnormal, the mandibular teeth being posterior to their normal relation to the upper teeth. The cause of this mal-occlusion was difficult to

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[1] It is intended in the future to publish a fuller account of these "Obstetrical Deformities."

account for until it was ascertained that the child was an example of face presentation and that the labour had been prolonged. Before complete extension occurs in face presentation the head

Fig. 200.
Diagram of a face presentation.

Fig. 201.
Shows the head before moulding.
(From Edgar's "Practice of Obstetrics.")

passes through the brow position and the diameter of engagement is the mento-vertical, i.e., from the point of the chin to the most distant point of the vertex (see fig. 200). Whilst this position is

FIG. 202.—The head after moulding in a case of face presentation. (From Edgar's "Practice of Obstetrics.")

maintained the jaw must be compressed. As fuller extension occurs the occiput is compressed against the spine and the chin slips up, the diameter of engagement then being the cervico-vertical and cervico-bregmatic; at this stage there is no undue pressure on the chin. It seems quite possible, therefore, that if labour is prolonged during the mento-vertical stage permanent injury may be done to the mandible.

Figs 201 and 202 are reproduced from *Edgar's Practice of Obstetrics* and show the face before and after moulding. The appear-

FIG. 203.—Models of a girl at eleven years with abnormal occlusion of the teeth associated with a difficult face presentation.

ance of the face after moulding suggests some retraction of the mandible.

Another of these cases is shown in fig. 203. The anterior upper teeth are unduly prominent. The child was breast-fed and there was no trace of adenoids. The occlusion is abnormal, the mandibular teeth being posterior to their normal relation with the maxillary teeth. In this case the labour was difficult and prolonged. The jaws of both parents are well-developed, and the remaining children in the family—four in number—have well-developed arches and normal occlusions.

The facts quoted above are sufficiently suggestive to warrant a full inquiry into a possible relationship between difficult labour and irregularities of the teeth.

(γ) Post-natal or Acquired after Birth

The majority of irregularities fall under this heading, and can be traced to (a) mechanical causes inducing "trauma," (β) the defects of septic processes in connection with the teeth, or (γ) morbid conditions leading to diminished or excessive growth of the maxillæ or mandible.

(a) Mechanical Causes.

The mechanical causes leading to deformities of the dental arch can be grouped under two headings:—

(i) Direct injury of the teeth or jaws.

(ii) Abnormal conditions of the surrounding soft tissues.

(i) *Direct Injury of the Teeth or Jaws.*

(a) *The Premature Removal of Teeth.*—With the removal of a tooth there is a tendency for the approximal teeth to come together. In the maxilla, this movement is brought about by the muscular pressure of the lips, the tension of the cheeks and the forward movement of the permanent molars; in the mandible, by the action of the tongue and the tilting movement of the permanent molars. The extent of the deformity depends on the tooth removed, the time of removal, the occlusion of the teeth, and the development of the bones.

The following examples will illustrate these points. If a second maxillary deciduous molar is removed after the eruption of the first permanent molar, the latter tooth will tend to move forwards, and the first deciduous molar backwards. The extent of the movement of the permanent molar will vary according to the degree of inter-

ference with the growth of the bone in the molar region. If there has been normal growth, and if the first molar is in good occlusion with the mandibular tooth (i.e., interdigitation of the cusps is well marked) the amount of forward movement will be slight. If, on the other hand, there has been interference with the growth of bone, the tendency of the permanent molar to forward movement will be marked, even though the occlusion may be good. The tendency of the first deciduous molar to move backwards is brought about by the muscular pressure of the lips, but the lips will not exert much influence if the occlusion with the mandibular teeth is good.

If a second deciduous molar is removed before the permanent molar has erupted, the forward movement of this latter tooth will

Fig. 204.—Model showing movement backwards of the second mandibular premolars following early extraction of the first permanent molars.

be marked, and in some cases it will encroach upon the whole space previously occupied by the deciduous tooth.

If a deciduous canine is removed at an early age, the closing of the space is mainly due to a spreading movement of the incisors, brought about in the maxillary arch by the lips and in the mandibular arch by the tongue. The deciduous molar may also move forwards, but this will depend mainly upon the forward pressure of the permanent molars.

If the lower first permanent molars have been removed before the eruption of the second premolars, the latter teeth occasionally erupt far back in the arch, as shown in fig. 204.

(*b*) *Caries of the Teeth.*—Loss of tissue from caries on the approximal surfaces allows the teeth to close on one another. A forward movement of the permanent molars often occurs from this cause.

(*c*) *Septic Processes in connection with the Teeth.*—The presence of septic teeth is a common cause of irregularities. Under normal conditions the loss of the deciduous teeth is due to absorption of their roots. When the tissue of the deciduous tooth has been robbed of nutrition in consequence of injury to the pulp, absorption takes place slowly and is often completely arrested. Such teeth obstruct the movement of the erupting tooth, deflect it from its course, and so cause it to erupt in an irregular position.

(*d*) *Fracture of the Jaws* in children is frequently followed by irregularity in the position of the permanent teeth located in the region of the fracture.

(ii) *Abnormal Condition of the Surrounding Soft Tissues.*

(*a*) *Habits.*—Certain habits are contracted by children, such as finger-sucking and lip-sucking, which, if persisted in, will

Fig. 205.[1]

produce deformed arches. In the habit of sucking the thumb or finger, the palmar surface of the thumb is placed against the palatal surface of the central incisors, the mandibular teeth being closed on the dorsal aspect. The pressure exerted causes the maxillary central incisors to protrude, so that the lower lip passes behind them and aggravates the protrusion when the mouth is at rest. At times the thumb or finger is inserted between the teeth in such a manner as to cause the teeth to impinge on the lateral

[1] From *Proc. Roy. Soc. Med.*

surfaces. Under such conditions, the maxillary incisors and canines are forced outwards and frequently upwards, producing a type of irregularity known as "open bite." Sucking of the lower lip or tongue may also produce protrusion of the maxillary teeth.

The prolonged and persistent use of the "baby comforter," or "dummy," is a fruitful source of dental deformity. Fig. 205, the models of a child aged five, illustrates the protrusion of the maxillary arch from this cause. The protrusion was well marked when the child was about eighteen months old.

Careful inquiry into the use of the "dummy" would seem to show that, if its use is persisted in, deformity of the maxillary

Fig. 206.—Maxillæ and mandible showing protrusion of the maxillary incisors as seen in children addicted to the habit of thumb-sucking.

dental arch will almost certainly result, and that the extent of the deformity will depend on the frequency with which the "dummy" is used, the period over which its use extends, and the presence or absence of rickets.

The maxillæ and mandible illustrated in fig. 206 show the type of deformity usually seen in children addicted to thumb-sucking. The maxillary incisors project, while the arch of the mandibular incisors is flattened.

There is reason to think that in these cases the force on the incisor teeth in the backward direction is resisted at the articulation, with the result that the neck of the condyle takes an inward direction, as shown in fig. 207.

(*b*) *Cicatrices.*—In cases where the soft tissues in the neighbourhood of the jaws have been injured the contraction of the cicatrix may divert the teeth from their normal positions. A case

Fig. 207.
Abnormal mandible, showing bend in the neck of the condyle. Normal mandible.

of protrusion of the lower incisors which followed an extensive burn of the soft tissues of the neck is shown in fig. 208.

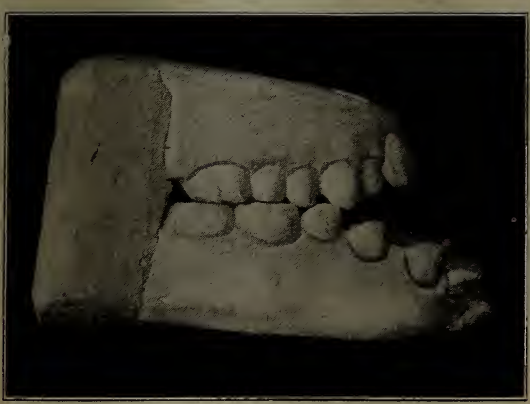

Fig. 208.—Models showing displacement of the mandibular teeth, the result of contraction of a cicatrix (Tomes).

(δ) Causes leading to Abnormal Growth of the Maxilla or Mandible

By far the greatest number of cases of irregularities of the teeth are the outcome of a diminished growth of the maxilla and the mandible. As regards the most suitable treatment of these cases there is considerable diversity of opinion, which will probably disappear as soon as the pathology of these cases has been established.

Before discussing possible causes, it may be advantageous to describe the morbid anatomy of a few specimens which fall under this group.

(i) *The Relation of the Maxillary-premaxillary Suture to Irregularities of the Teeth*

An examination of skulls of children suggests that growth of bone at the maxillary-premaxillary suture continues until the eruption of the second dentition is well advanced, and there is reason to believe that the premature closing of the suture is causally related to a crowded arrangement of the incisor teeth.

In the infant this suture is well marked and runs posterior to the foramina leading to the permanent incisor teeth and ends near the margin of the canine socket. With the advance of years the

Fig. 209.—Maxillæ of a child about three years of age.

suture tends to be separated by an increasing interval from these teeth. The outer portion of the suture fills in first, the inner portion being often well marked in the skulls of children of twelve to sixteen years of age.

Palates with well-marked sutures are as a rule wider than those where the suture is ill-defined. A comparison of the inter-canine and inter-second deciduous molar widths of forty-seven specimens gives the following figures:—

		Inter-canine		Inter-second molar
Well-defined sutures (32 specimens)	...	22·5 mm.	...	27·8 mm.
Ill-defined sutures (15 specimens)	...	21·9 mm.	...	26·8 mm.

It will be noted that the difference in the width of the arches is greater between the canines than the molars.

Maxillæ showing well-defined sutures are shown in figs. 209 and 210. In both these specimens the dental arches are well formed and there is no crowding of the teeth.

Fig. 210.—Maxillæ of a child aged four years six months. Each premaxilla is developed from two centres.

In the maxillæ (fig. 211) from a child three years two months the outer two-thirds of the sutures are closed, the teeth are curved inwards and are crowded. The canine and molar widths

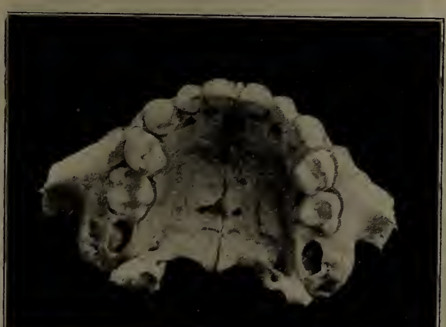

Fig. 211.—Maxillæ of a child aged three years two months with crowded incisors associated with a partially closed suture.

are 19 mm. and 23·5 mm., the normal average being 22·5 mm. and 27·8 mm. The conclusion to be drawn from the examination

of dried specimens is that early closure of the suture and crowding of the anterior teeth are definitely related.[1]

(ii) *Abnormal Position of the Permanent Teeth in their Crypts*

Normally the developing permanent teeth in the maxilla are arranged as follows: The crowns of the central incisors have their anterior or labial surfaces looking forwards, the distal limit of the crown being partly behind the root of the deciduous lateral incisor; the permanent lateral incisors lie in a plane posterior to that of the central incisors, and the distal limit of the crown is covered by the root of the deciduous canine—indeed, the permanent lateral lies in close proximity to the anterior root of the first deciduous molar (see fig. 212). The permanent canine is high up in the bone and lies in a plane anterior to that of the lateral; the developing pre-

Fig. 212.—Left maxilla of a child about six years of age, to show the position of the permanent teeth.

molars are embraced by the roots of the deciduous teeth. In the mandible a similar arrangement exists.

The next six specimens will serve to illustrate some abnormal positions of the developing teeth.

[1] A fuller account of the relation of the maxillary-premaxillary suture to irregularities in position of the teeth will be found in the *Dental Record*, February, 1914.

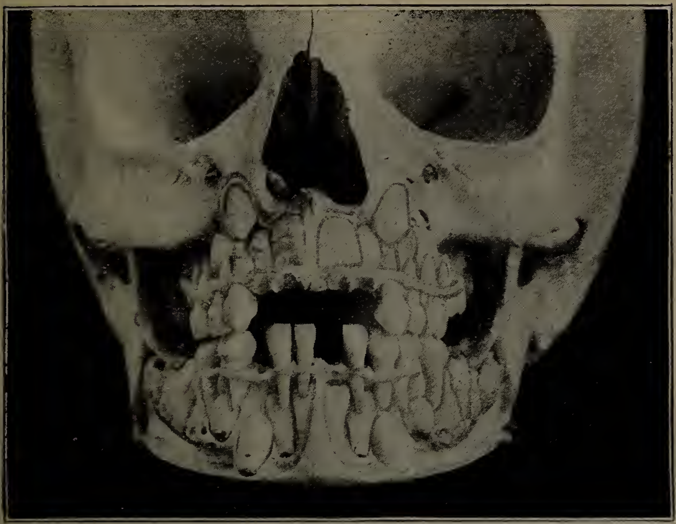

Fig. 213.—Skull and mandible of a child aged five years six months, showing irregularity in position of the right maxillary incisors.

The skull of a child of five years six months is shown in fig. 213. Several of the deciduous teeth have been lost, but those that remain are slightly crowded. In the left maxilla the relative positions of the central and lateral incisors to one another are normal; the central incisor, however, is a little tilted on its long axis. In the right maxilla the central incisor is tilted so that the mesial angle

Fig. 214.—In this specimen there is marked irregularity in the position of the developing maxillary incisors.

is forward and the lateral incisor overlaps the distal corner of the labial surface. The sutures are closed in their distal halves.

Fig. 214 reveals a considerable departure from the normal in the left maxilla. The central incisor is rotated so that the mesial angle looks almost directly forwards; the lateral incisor is also rotated, but to a lesser extent, and overlaps the central incisor.

The condition of the deciduous teeth as regards spacing cannot be definitely determined as several of the teeth are missing, but an examination of the bones conveys the impression that there was ample room in the arch.

In the next specimen (fig. 215), five years nine months, the upper deciduous incisors have been removed to show the position

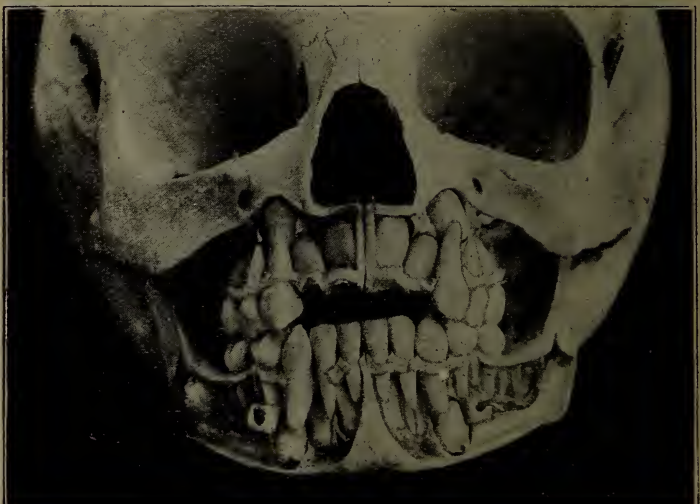

Fig. 215.—Skull and mandible of a child aged five years nine months, showing irregularity in position of the developing maxillary incisors.

of the permanent teeth. The maxillary central incisors have their mesial borders rotated a little forward, and the lateral incisors overlap their distal corners. The deciduous teeth, when in position, are bent a little inwards, and there is slight crowding. The sutures are partially filled up in their outer quarters, the right a little more than the left. In connection with this fact it is interesting to note that the irregularity of the permanent teeth is more marked on the right side.

In fig. 216 the right maxillary lateral incisor slightly overlaps the central incisor and the mesial angle is tilted forward. On the left side the lateral slightly overlies the central, the latter tooth

FIG. 216.—Skull and mandible of a child about six years of age, showing irregularity in position of the developing maxillary incisors.

being a little rotated. The upper deciduous incisors are missing but the lower teeth show good spacing. The inter-canine width is slightly above and the inter-molar width equal to the normal

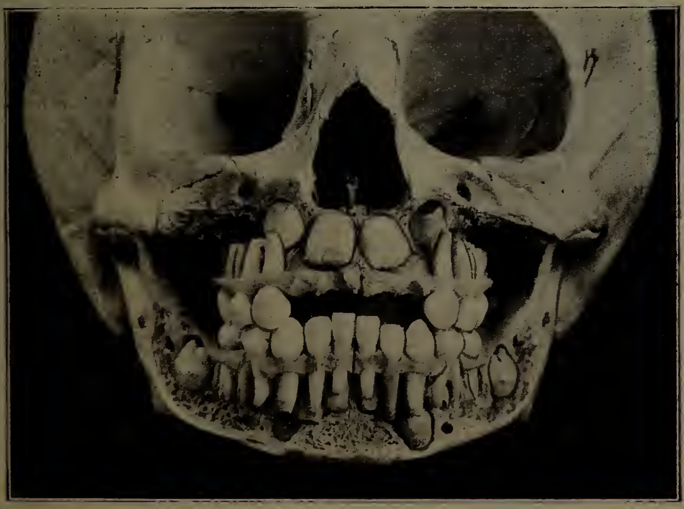

FIG. 217.—Skull and mandible of a child about five years of age, showing considerable irregularity in the position of the developing maxillary incisors and canines.

average. The suture on the left side runs near to the deciduous canine socket; the right suture terminates forward of the deciduous canine.

Another variation in the position of the permanent incisors is shown in fig. 217. The maxillary centrals are placed with their long axes towards the mid-line and the canines lie with the crowns pointing away from the mid-line. The opening of the anterior nares is small, and the whole specimen conveys the impression that there is a want of growth of the body of the maxilla.

Fig. 218 is from a skull of a child between six and seven years of age. The maxillary incisors are distinctly crowded; the right

Fig. 218.—Skull and mandible of a child between six and seven years of age. The maxillary incisors are developing in abnormal positions.

central is partially rotated and is overlapped by the lateral incisor; the left central has a distinct slope away from the mid-line and overlaps the lateral. The arch of the deciduous teeth is well formed, and the teeth are well spaced; the maxillary-premaxillary sutures are distinctly closed in their distal halves.

(iii) *Acquired Conditions interfering with the Growth of the Jaws*

(a) The Method of Feeding in Infancy.—There is ample testimony that the method of infant feeding influences the shape

of the palate and dental arch. A series of measurements made of children free from adenoids produced the following data:—[1]

	A	B
Breast-fed	34·85 mm.	26·31 mm.
Hand-fed	34·1 ,, ...	25·61 ,,

In hand-fed children there is a greater tendency to abnormal occlusion than in breast-fed, and the width of the palate compared to the height is also slightly less, being 2·63 in breast-fed and 2·52 in hand-fed.[2] These facts would seem to show that breast-fed children have slightly broader arches than those fed by artificial methods. These figures are taken from patients in private practice; figures gathered from patients in hospital show a greater difference between the breast-fed and hand-fed.

It seems quite feasible that this variation in the palates and arches of breast- and hand-fed children is due to the difference between the action on the palate of the teat and the nipple. An infant, when at the breast, takes not only the nipple, but a considerable portion of the areola into the mouth, and the tongue is often seen protruding over the lower lip. In the act of feeding the mandible is first slightly depressed and then raised so as to squeeze the breast against the palate, and the milk so expelled is then swallowed. The jaws then separate to admit more milk into the flaccid apex of the breast, and the process is repeated. The general effect of this action is to bring the muscular tissue about the jaws into activity, and to spread the palate.

With the modern-shaped bottle the child is held on the left arm and the bottle is kept at such an angle that the milk passes into the teat; the mandible then exerts a squeezing action and the milk, passing into the mouth, is swallowed. If the bottle is used correctly, very little sucking is performed by the child, the whole

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[1] For the purpose of obtaining measurements the following plan was adopted:—

(*a*) The breadth between the first permanent molars, the point chosen being the gum margin immediately in line with the fissure in the palatine aspect of the teeth. This is denoted throughout by A.

(*b*) The breadth between the first deciduous molars or first premolars, the point chosen being the gum margin at the point corresponding to the centre of the palatine aspect. This is denoted throughout by B.

[2] To obtain these measurements plaster casts were made of the palate, and these were divided at a point corresponding to the middle of the second deciduous molar or second premolar. Tracings on paper were then made and a line drawn between the gingival edges, and from the centre of this base a line was drawn at right angles to ascertain the height.

act simulating that of the child at the breast; but there is this difference, the teat is not so tough and resistant as the breast, and the pad in the mouth exerts less pressure on the anterior part of the palate; still further, the backward force of the breast upon the anterior part of the arch is absent.

The ideal teat has yet to be designed, but it seems obviously desirable that so far as possible the natural action of the nipple should be reproduced, and to this end teats for bottles should be made flat and broad at the base, a little longer than those at present used and of a tougher character. Now that so many children are hand-fed the matter is of considerable importance.

The modern feeding-bottle is, however, a great improvement on the old tube feeding-bottle. In the latter the teat, about 1 in. to $1\frac{1}{2}$ in. long, is of a narrow tube-like type. In taking the milk from this bottle, the tongue is closed around the teat and the act of suction is brought into play. The mandible is not brought into use, and the whole action of the muscular tissue of the cheeks is towards the median line, and not away from it as is the case with the breast-fed child. The action tends to narrow the palate rather than to spread it, and the measurements of models substantiate this. In forty-one patients where the tube bottle had been used the average measurements were:—

A		B
32·14 mm.	... ...	23·05 mm.

These figures, compared with those of hand-fed by ordinary boat bottles, show a marked diminution in width, especially in the premolar region.

(b) The Effects of Disease on the Growth of the Jaws.

(i) ADENOIDS.—Nasal obstruction arising from the *presence of adenoids* greatly influences the growth of the maxilla, the effect produced depending on the period of onset and the persistence of the adenoids. The earlier the age at which the adenoids appear the more marked will be the effect on the teeth and palate and the longer they persist the greater will be the damage.

The Character of the Deformity.—If the mouth of a child of about four years of age that was breast-fed and that had not had adenoids be examined, the teeth will be found to form a regular arch, with the anterior teeth separated by slight spaces. The vault of the palate in section across the first deciduous molars will be oval-shaped, and, on longitudinal section, will rise with a gentle incline from behind the front teeth to the vault (see fig. 219).

In a child that has suffered or is suffering from adenoids, the

teeth will be crowded and the muco-periosteum of the palate will present a somewhat puckered appearance (fig. 220); the vault, in transverse section, will be dome-shaped and, in longitudinal section,

FIG. 219.—The model of a child that was breast-fed and had not suffered from adenoids.

will rise somewhat abruptly from the posterior aspect of the incisors. The palate will have the appearance of having been pushed up towards the front. The deciduous molars may occlude too far forward, but this is the exception rather than the rule. If the

FIG. 220.—Models of a child, aged five years seven months, that had suffered from adenoids from the age of two years. The puckered appearance of the muco-periosteum covering the hard palate, and the crowding of the teeth are well shown.

adenoids have been removed before the age of six and have not been severe, the effect on the permanent teeth will be to crowd the upper incisors, and the disturbance will range from a slight tilting of the lateral incisors to an irregularity involving the four anterior teeth

(fig. 221). The first permanent molar erupts in good position, and, provided that the deciduous molars are retained for their normal period, the premolars will erupt in normal occlusion. The canines, when in place, will show a slight slope of the roots towards the

FIG. 221.—Models of the case shown in fig. 220 after the eruption of the incisors. Note the irregular position of the incisors.

median line. The only permanent irregularity will be the crowding of the incisor teeth.

If the adenoids have been severe and of long duration, an additional effect on the arch will be seen in the region of the first molars. The first molar, when erupted, often fails to assume a vertical position, and lies with a general slope backwards. This is

FIG. 222.[1]—Models of a boy aged seven. He had been operated on for adenoids three times.

[1] From *Proc. Roy. Soc. Med.*

well shown in fig. 222 the models of a child who suffered from adenoids. This tooth is in normal occlusion, but it is not difficult to foresee that, as soon as the second deciduous molar is removed, rapid forward movement of the first molar will result in an encroachment on the space for the premolars and an abnormal occlusion.

In some cases the growth in the molar region is so much restricted that the first molar erupts in such a way as to lead to absorption

FIG. 223.[1]

of the posterior roots of the second deciduous molar (fig. 223). Under such conditions it is obvious that abnormal occlusion must result and the space for the premolars be considerably curtailed.

If the permanent molars do not move forward, the premolars and canines erupt in normal position, and the only deformity of the arch that remains is the slight irregularity of the incisors. If the permanent molars do move forward the space for the premolars and molars is reduced and a general crowding of these teeth results.

There would appear to be a slight decrease in the width of the arch in children with adenoids, as compared with those free from adenoids, the difference being slightly less than 1 mm. The subjoined figures would appear to substantiate this view.

	A	B
	Breast-fed.	
Without adenoids (20 cases) ...	34·85 mm. ...	26·31 mm.
With „ (13 „) ...	33·80 „ ...	25·19 „
Difference	1·05 mm. ...	1·12 mm.
	Hand-fed.	
Without adenoids (34 cases) ...	34·10 mm. ...	25·61 mm.
With „ (30 „) ...	33·36 „ ...	24·90 „
Difference	0·74 mm. ...	0·71 mm.

[1] From *Proc. Roy. Soc. Med.*

The measurements recorded above are from patients treated in private practice.

With persons who have suffered from adenoids the third molars often erupt with the occluding surfaces facing backwards and outwards.

Many of the gross lesions of the jaws which are found in association with adenoids are not necessarily the direct result of the adenoids alone. Usually there are other contributory causes, the influence of which will be considered subsequently.

The Factors Producing the Deformity.—There is a wide divergence of opinion as to the precise manner in which the deformities of the palate associated with adenoids are produced. It has already been pointed out (p. 107) that the efficient performance of nasal respiration was essential for the full growth of the palate. This function is hindered or may be entirely in abeyance when there is nasal obstruction, and the result is that the growth of the jaw is considerably hampered.

H. Campbell, dealing with the subject of nasal respiration, says, "When we reflect that a person normally breathes some twenty thousand times through the nose in twenty-four hours, and that the constant flow of air through the nasal passage attracts an abundant supply of blood to the nasal mucous membrane, for the purpose of warming and moistening the air, giving off to it about two quarts of water per diem, it is manifest that the cessation during the developmental period of the respiratory function of the nose must interfere with the proper development of the nasal apparatus, just as early excision of an eyeball tends to defective development of the corresponding orbit."

The interference with growth would appear to occur mainly in the region of the incisors and the molars. Lack of use of the muscles of the anterior nares, in addition to the loss of stimulus to the nasal mucous membrane, inhibits the growth of the premaxillæ. The restriction of growth from this cause would seem to afford an explanation of the fact that crowded incisors are almost always associated with cases in which adenoids develop during the first six years of life. The want of growth in the molar region is due to the lack of expansion of the antrum arising from disuse, and the want of growth of the maxilla is correlated with a diminished growth of the mandible.

The *decrease in the width of the arch* seen in patients with adenoids may be due to the general want of growth of the maxilla in conjunction with the pressure exerted by the tension of the cheeks in consequence of the open mouth.

The measurements quoted on p. 153 show a slight narrowing of the arch in children affected with adenoids. In many of the cases included in the series the nasal obstruction was not sufficient to cause excessive mouth-breathing and the effect of the tension of the cheeks would not be marked; still further, in each case the full complement of teeth was present. The figures, however, suggest that the tension of the lips is an active factor in narrowing the arch. It will be noticed that in the breast-fed children affected by adenoids there is a greater proportional narrowing of the arch than in hand-fed children similarly affected. At first sight this difference is rather surprising, but the explanation is as follows: The arch of the breast-fed child is broader and the teeth more spaced than in the hand-fed child; pressure brought to bear on the outer surface of the arch forces the teeth inwards; in the breast-fed child the teeth must move a greater distance before mutual antagonism of the teeth occurs than in the hand-fed child, and hence can be explained the greater proportional reduction in the width of the arch in the breast-fed child. These facts support the view that the tension of the cheeks is an important factor in reducing the width of the arch.

It is evident that when once the teeth are laterally in contact the resistance to the lateral pressure is increased, and that any further narrowing of the arch will depend upon whether the pressure of the cheeks is sufficient to overcome the resistance of the arch. If the mouth-breathing is extreme the effect of the lateral pressure of the cheeks is accentuated and may become sufficient to drive forward the anterior curve of the arch and cause protrusion of the teeth.

If the continuity of the arch is broken by the loss of teeth the narrowing will be accentuated. That the constant tension of the cheeks, and especially the tension of the muscles, does eventually affect the arch is shown by an interesting case recorded by Lambert Lack,[1] in which a child had suffered from unilateral facial paralysis from infancy, in addition to mouth-breathing from adenoids. On the unparalysed side the arch was crushed in; but not on the paralysed side.

A word must be said with regard to the high arch of the palate seen in children suffering from marked adenoids. It has been maintained that this is due solely to the lateral pressure of the cheeks, but that view is open to criticism, as in many cases the narrowing is very slight and does not account for the increased

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[1] *Trans. 17th Int. Med. Congress*, Section of Stomatology, p. 67.

height of the palate. It seems probable that the height of the palate may be due to interference with the growth of the sphenoid and the septum of the nose.

"The hard palate in the infant is normally high arched, and at birth it lies above the level of the Eustachian tubes, but later on becomes considerably lower. This alteration is due to the downward growth of the hard palate, so that one factor in the production of a highly arched palate is a lack of development of the walls of the nose, more especially of the sphenoid and the septum." Any factor such as adenoids will interfere with the growth of the nasal septum, and so retard the proper development of the hard palate and consequently its descent.

To sum up, it would seem probable that the *deformities associated with adenoids are to be attributed mainly to defective growth*

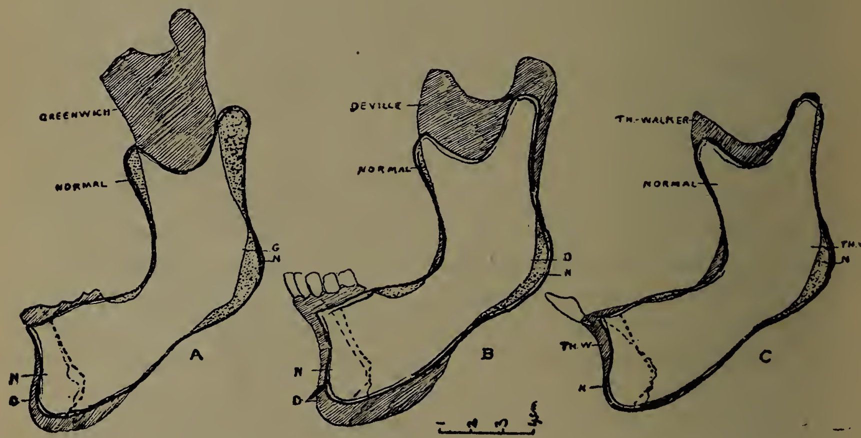

Fig. 224.
From a paper by A. Keith (*Dental Record*).

of the maxillæ, and that the narrowing of the arch is in a large measure due to the tension of the cheeks, the severity of the deformities depending upon (1) the degree of adenoids and consequent mouth-breathing, (2) the duration of the adenoids, (3) the loss of teeth from the dental arch.

(ii) *Rickets.*—There is no evidence to show that rickets by itself can be regarded as the cause of deformed arches. But as the bones in rickety persons are imperfectly formed and readily yield to pressure, the deformities resulting from adenoids or from the use of the "dummy," or from thumb-sucking, will be more pronounced if rickets is present.

(iii) *Acromegaly.*—In this condition growth recommences in certain parts of the body, the mandible being one of those affected. The ramus elongates, there is growth along the alveolar border, at the chin, and also at the lower border of the body. These changes are diagrammatically shown in fig. 224, the mandible of a normal person being superimposed on that of three acromegalic mandibles.

A Keith,[1] who has given considerable attention to the subject, considers that the changes are due to over-action of the pituitary secretion. "It somehow sensitizes the osteoblasts of the masticatory apparatus—not only wakens up growth in them, but renders them highly susceptible to the mechanical influences to which they are subject when in action."

(iv) *Oxycephaly.*—In the condition known as oxycephaly the maxillæ are poorly developed, the length of the maxilla being reduced in proportion to the anterior-posterior diameter of the skull. The antra are usually rudimentary. The mandible does not show any changes.

Morley Fletcher[2] gives the following description of the jaws in one of his cases where the oxycephaly was well marked: "The superior maxilla was shortened from before backwards. The hard palate formed a narrow, very pointed arch. The second and third molars were absent in the upper jaw and could be made out in the skiagram lying above on what appeared to be rudimentary antra. Lower jaw underhung teeth normal in number."

In oxycephaly there is synostosis of the coronal and sagittal sutures and this leads to a lack of growth of the maxilla. There is some little evidence that the changes are related to an alteration or abnormal development in the pituitary body.

(v) *Progeria.*—This interesting condition was first described by Hastings Gilford. The individual is the victim of delayed or arrested growth—infantilism—to which is added senilism, a term used to designate prematurely senile changes.

The skeletal changes in a case of progeria have been fully described by A. Keith.[3] The condition of the jaws and teeth is most instructive because it seems to shed light on the problem of the crowded mouth. The palate is very little larger than that of a child at birth, the length being less reduced than the width. On the other hand, the teeth are as advanced in formation as one would

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[1] "Certain Factors in Tooth Eruption," *Dental Record*, vol. xxxiii, p. 769.

[2] "On Oxycephaly," *Quarterly Journal of Medicine*, April, 1911, vol. iv, No. 15.

[3] "Progeria and Ateleiosis," *Lancet*, February 7, 1913.

expect to find in an individual of eighteen years of age, but are placed in an irregular manner. The lateral incisors and third molars are absent and the canine unerupted. In the mandible the lateral incisors are absent, the premolars are embedded in the bone, the first molars have been destroyed by caries, and the second molars are erupting from the inner aspect of the coronoid process. The third molars are absent (figs. 225 and 226).

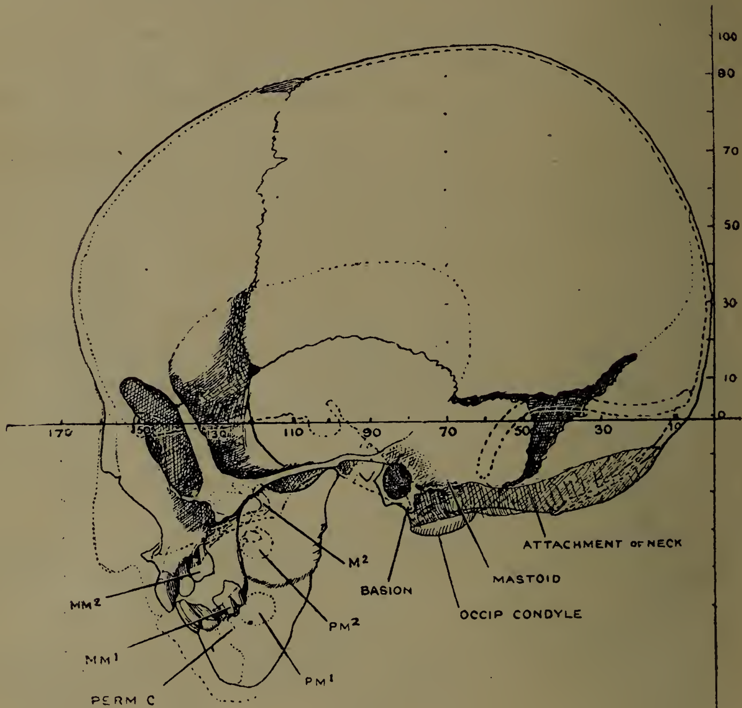

Fig. 225.

From a paper by A. Keith (*Dental Record*).

(vi) *Achondroplasia.*—In this disease there is a slowing down or arrest of bone growth at epiphyseal lines and, owing to synostosis of the bones of the base of the skull, the maxilla may be deformed. The malformation consists in a retraction of the face and a tilting upwards of the anterior part of the palate.

The manner in which the teeth and jaws are affected in cases of acromegaly, &c., where the disease is well marked is indicated above. It is probable that these diseases are frequently present in

a lesser degree, and that with further knowledge they will be found to be a more common cause of irregularities of the teeth than has hitherto been suspected.

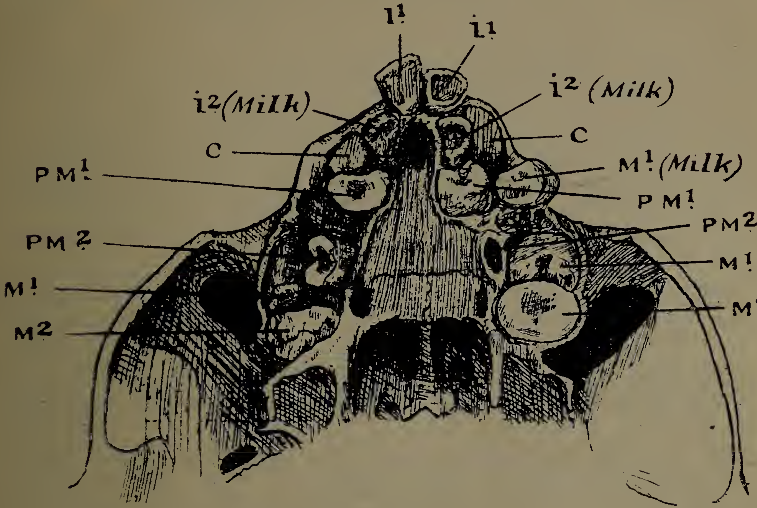

Fig. 226.
From a paper by A. Keith (*Dental Record*).

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CHAPTER VI

Abnormalities in Position of the Teeth.—Treatment

Treatment in General—The Movement of Teeth by Mechanical Appliances—The Movement of Teeth by Surgical Methods

(A) TREATMENT IN GENERAL

(1) Prophylactic.—Our knowledge of the causes of irregularities of the teeth is as yet far from complete, but year by year investigation discloses fresh facts which assist us in removing or ameliorating those causes, and it is important, therefore, that the student should keep closely in touch with the results of research.

It is of primary importance that breast-feeding should be insisted on wherever it is practicable, but if hand-feeding is necessary the food should be administered for preference by means of the spoon or feeding-cup. The use of the comforter should be strongly deprecated. Every care should be taken to prevent caries of the deciduous teeth. A diet requiring plenty of mastication is essential, and proper nasal breathing should be assiduously encouraged. Should nasal obstruction be caused through the presence of adenoids, or from any other condition treatment should be accorded as speedily as possible, in order that proper nasal respiration may be restored. If the teeth of a breast-fed child are maintained in a healthy and efficient state and nasal breathing is promoted there is little danger of irregularities arising during the second dentition.

Careful supervision of the mouth during the period of dentition will go far to prevent or, at any rate, to ameliorate irregularities.

Early treatment of caries in the deciduous molars will often prevent their premature loss, while the timely removal of a deciduous tooth will often prevent a permanent tooth from assuming an abnormal position. Special attention should be bestowed upon the first permanent molars. Any cavities which appear should immediately be filled. If caries does appear on the anterior surface of the permanent molar, the advisability of removing the second deciduous molar and making the surface of the permanent

molar self-cleansing must be considered. The successful preservation of the first permanent molar far outweighs in importance the slight moving forward of the tooth which might result from the removal of the second deciduous molar. To secure good results, children's teeth should be examined at least three times a year, and the necessity for constant supervision should be impressed on the parents.

(2) Remedial.—Whenever there is doubt as to the best method of treatment it is advisable to take **models of the mouth** to be studied in connection with a chart on which the condition of the teeth has been carefully noted. In this way points often become apparent which would be missed by a mere examination of the mouth. Where a case comes under observation at an early stage, it is advisable to take models periodically in order that the development of the mouth can be watched and perhaps some light gained as to the best method to pursue in the treatment.

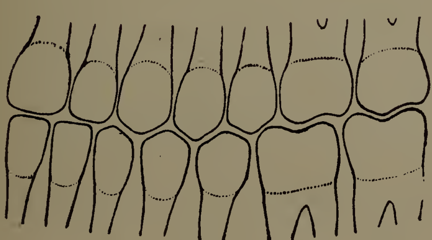

Fig. 227.

The teeth must be carefully examined with special reference to the following points:—

(α) The general character of the teeth.

(β) The presence and extent of caries, especially on the approximal surfaces.

(γ) The directions of the roots of the teeth. (The value of this point is referred to on p. 218.)

(δ) The occlusion of the teeth.

The last point is of special importance if extraction is indicated. Many of the indifferent results which follow treatment by extraction are due to the teeth having been removed without regard to occlusion.

The teeth have a natural tendency to change their positions in the mouth termed **"travelling of the teeth,"** and in connection with this movement the "bite" or occlusion of the teeth plays an important part. If a normal articulation (fig. 227) be examined,

it will be observed that the opposing teeth present inclined planes to one another, and this is particularly noticeable in the premolar region. With each act of mastication pressure is brought to bear upon these surfaces and as long as the resistance remains equal in all directions the tooth retains its position. Remove this resistance, wholly or in part, and the force exerted by the muscles with each act of mastication will tend to force the teeth in the direction of least resistance. Take, as an example, the case diagrammatically illustrated in fig. 228. The first molars have been removed. Each time the posterior plane of the second lower premolar strikes the

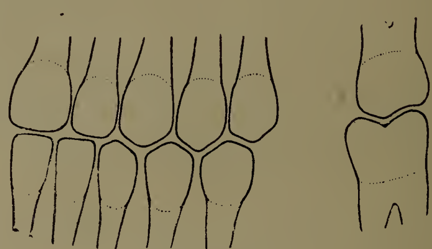

Fig. 228.

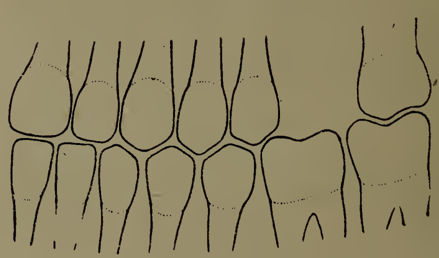

Fig. 229.

anterior plane of the second upper premolar the tendency will be to drive the latter tooth in the direction of least resistance, namely, backwards. When once this tooth has travelled backwards, the resistance to the movement of the second lower premolar in the posterior direction is removed, so that the force of the posterior plane of the first upper premolar striking the anterior plane of the lower second premolar will tend to drive the latter also in a backward direction. In like manner, the posterior plane of the first lower premolar will tend to drive back the first upper premolar. In addition to the power derived from the muscles of mastication, the force exerted by the lips, tongue, and the process of eruption are important

factors in producing the natural movement of teeth. The lips exert force in a backward direction, the tongue in a forward direction. When employing extraction for the correction of an irregularity, an endeavour should be made to "unlock" the bite. This will be more easily understood by a reference to fig. 229. For the sake of argument we will suppose that the canine has erupted externally to the arch. To provide space the first upper molar only is removed. The bite will remain locked—in other words, the second premolar will require mechanical means to train it in a backward direction, and even then will occlude with the molar—an unsatisfactory condition. Mechanical means will also be required to retract the first premolar. If the lower first molar is removed as well as the upper, mechanical methods can be avoided to a very great extent, and there will be less interference with the efficiency of the bite.

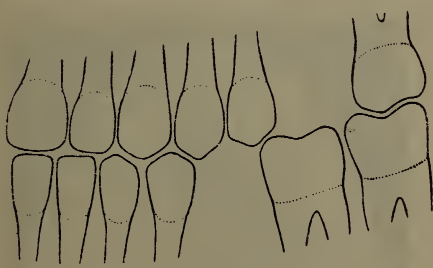

Fig. 230.

When removing teeth in both maxilla and mandible, opposing teeth should if possible be selected. A glance at the diagram (fig. 230) will show the disadvantage of not following this course. In the upper the first molar has been removed, and in the lower the second premolar. There is considerable destruction of the masticating area, and moreover mechanical methods must be used to retract the teeth. Removal of the upper and lower second premolars, or the upper and lower first molars, would have interfered far less with the masticating area, and would have unlocked the bite and allowed the teeth to travel backwards unaided by mechanical means.

In employing extraction the desirability of maintaining the **Teeth in their proper relationship to the Median Line of the Face** should, for æsthetic reasons, be borne in mind. Any deviation to one side or the other in the direction of the incisors causes an appreciable disfigurement, and, in the case of girls, this is important from an æsthetic point of view. The centre of the mouth is likely

to shift when the bite is unlocked on one side and not on the other. Take, as an example, a case where it has been necessary to remove the upper first premolar on the left side. The posterior resistance to the canine and lateral being removed the pressure of the lip tends to drive all the anterior teeth to that side and so causes the centre to shift. An example is shown in fig. 231. The patient's appearance has suffered considerably. Removal of the first right upper premolar as well as the first left upper premolar would have prevented the disfigurement because, the posterior resistance on both sides being removed, the lips would have forced back the anterior teeth equally on both sides. Removal of one second upper premolar will not cause the centre to shift because the bite will be locked by the first upper premolar occluding with the lower premolars, but removal of the fellow tooth in the lower will withdraw the posterior resistance and permit the first premolars—upper

Fig. 231.

and lower—to shift back and so produce an alteration in the centre of the mouth. Other examples could be quoted. Removal of the first upper and lower right molars and the first upper left molar would cause the centre to shift towards the right side because the bite is locked on one side and not on the other.

Skiagrams of the teeth will be found most useful in cases where doubt exists as to the directions of the roots of teeth, or as to the presence or absence of unerupted teeth.

In any case where there is a question of treatment by mechanical methods the **general health and temperament** of the patient must be considered. With weak, nervous children mechanical treatment should, for obvious reasons, be avoided if possible. Again, in all cases requiring mechanical treatment the thorough co-operation of parents and patients is most essential to success. Regulating apparatus, unless constantly worn and properly attended to, does

more harm than good. If the practitioner has reason to believe that his instructions will not be faithfully carried out, prolonged mechanical treatment should be avoided.

Other points to be considered are the **age** and the **sex** of the patient. With regard to the former it should be remembered that the difficulty of moving and retaining the teeth in a new position increases with the age of the patient. As a rule, it is not advisable to attempt correction of irregular teeth by mechanical means in adults. The older the patient the more difficult the teeth are to move and retain in a new position. Again, the older the patient the greater the danger of starting pathological changes in the periodontal membrane.

In deciding on the method of treatment, attention must be given to the **facial expression and type of face.** For example, a narrow arch may be accompanied by a narrow face with a small mouth and correspondingly small features, all of which are in harmony. Expansion or spreading of the arch under such conditions might mar the character of the face.

The removal of the canine usually produces an ugly flatness of the upper lip and allows the angles of the nose to sink.

In cases where, with protrusion of the upper teeth, the lower lip is unduly flat, but the lower teeth are crowded, with perhaps the canines slightly prominent, an attempt to regulate the canines by bringing them into line will tend to increase the flatness of the lower lip and to accentuate the protrusion of the upper teeth.

(B) MOVEMENT OF TEETH BY MECHANICAL MEANS AND REGULATING APPLIANCES

The movement of teeth by mechanical means is accomplished by the application of certain forces which act from a fixed base known as "the point of delivery." The resistance of the point of delivery, or anchorage, must be greater than that of the tooth or teeth to be moved. This is essential, and is frequently overlooked.

The point of delivery is usually obtained from the resistance of teeth either by means of a well-fitting plate or by embracing two or more teeth with a clamp or band, the force to be used being attached to the plate or band. In a few forms of apparatus the occiput is utilized as the point of delivery. Regulating appliances are thus divisible into two main groups: (α) removable, (β) fixed.

(α) **Removable Appliances.**—The successful working of a regulation plate depends mainly upon accurate fitting, and great care should therefore be taken in obtaining models of the mouth.

The best material for the plate is vulcanite. The back teeth should usually be capped, as the real point of delivery is obtained from the teeth, and by capping them a much firmer hold can be obtained. Plates must be carefully adjusted to the bite of the opposing teeth. The plate should be tried in the mouth and the bite adjusted by the aid of a proper articulator. It is well to allow the lower teeth to bite "well home" into the vulcanite as the plate is then kept more firmly in position, and, when the mouth is closed, the opposing teeth also act as part of the point of delivery.

The Forces employed for Moving Teeth.—(i) **The screw** is perhaps the most powerful. The types suggested by E. H. Angle are neat and efficient.

The screw must be adjusted at regular fixed intervals, only a slight degree of force being applied at each visit. The force exerted by a screw is not continuous, but this is evidently no disadvantage

Fig. 232.

as the results obtained from screw force in regulating teeth are entirely satisfactory.

(ii) **The Wedge.—Hickory wood** compressed laterally is mostly used. The saliva moistens the wood causing it to expand and so exert force. In using wooden wedges, the grain of the wood should lie parallel to the direction in which it is proposed to move the tooth. The wedge will be found most useful for forcing incisors forward. The method of adjusting the wooden wedge is shown in fig. 232. A double dovetailed slot is cut in the vulcanite plate, one broad end being away from the tooth and the other being towards the palatal aspect of the plate. Into this slot the hickory wedge is placed. Wedges of hickory wood are also useful for forcing the premolars backwards.

Wedging may be carried out by the aid of vulcanite pegs. Cone-shaped holes are drilled in the plate and in place of the rubber a vulcanite peg is inserted and is left sufficiently long to prevent the plate being forced at once into place. The peg is also arranged

with a sloping surface so that at first it presses on the tooth near the cutting edge and as the plate is driven up into place by the lower teeth so the tooth is forced forwards. It is important that the lower incisors should occlude with the plate and so increase the force transmitted to the teeth to be moved.

(iii) **The inclined plane** is most usefully employed when it is necessary to force forwards three or four maxillary incisors. For this purpose a plate is made capping the lower teeth and an inclined plane is fixed to the plate, so that when the mouth is closed the teeth to be moved impinge on the sloping surface and are thus driven forward. The inclined plane must be used with care as the soft tissues may be injured if the teeth are forced forward too quickly.

(iv) **Elasticity.**—The force obtained from the elastic properties both of rubber and metals, especially the latter, is most useful for mechanical regulation of teeth.

(*a*) *Rubber.*—This material is generally used in the form of small bands. There is always some difficulty in retaining the bands in position on the teeth, the tendency being for the bands to slip towards the necks of the teeth and cause inflammation. This can be overcome by cementing to the teeth metal bands with hooks attached. The rubber bands require frequent renewal and are somewhat uncertain in their action.

(*b*) *Pianoforte Wire.*—This is a most useful material, light, strong and inexpensive, and in skilful hands it is capable of being utilized to produce any movement, i.e., pulsion, traction, or torsion of a tooth. Moreover it is constant in its action and can be easily controlled. The wire used should be thin (gauges No. 14 to 17). The disadvantage of the wire is the tendency to oxidize in the vulcanizer, but this can be overcome by tinning the wire. The following method is suggested by T. A .Coysh.[1]

"After cleaning the wire thoroughly it is dipped into chloride of zinc solution and then for an instant into melted tin which must not be too hot and the surface of which must be quite clear. Upon removal from this the surplus molten tin is quickly shaken off and the spring cooled in cold water."

Pianoforte wire is used to the best advantage when curved or coiled; in this way greater springiness is obtained. The twist given may be similar to that shown in fig. 233, or to that seen in fig. 234. For the manipulation of pianoforte wire the pliers designed by G. Northcroft and shown in fig. 235 will be found most useful. In

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[1] *Dent. Rec.*, vol. xi, p. 109.

twisting up the wire, anything approaching an angular bend must be avoided. Care must be taken to arrange that the force of the spring acts in the direction in which the tooth is to be moved. A bend should be made in the wire at the free end where it impinges

Fig. 233.

Fig. 234.

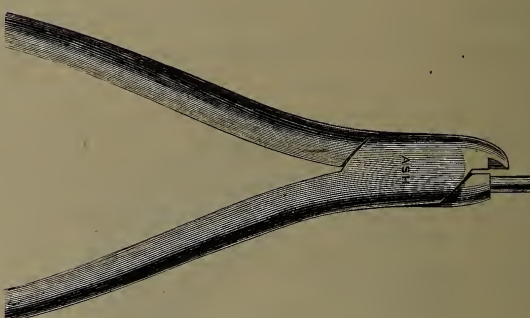

Fig. 235.

Fig. 236.—Plate for pushing outwards and rotating lateral incisors.

on the tooth as the wire can then be more easily adjusted in the direction required. It is also important that the coil or turn which gives the spring should be in a plane parallel to the direction of the required force. In figs. 236 to 243 some methods of employing pianoforte wire are shown.

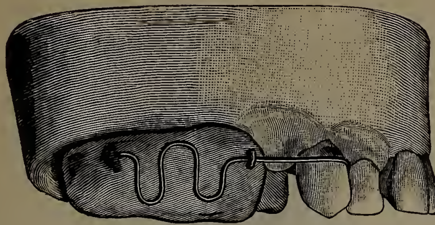

Fig. 237.—Plate for retracting a canine.

Fig. 238.—Plate for rotating a maxillary central incisor.

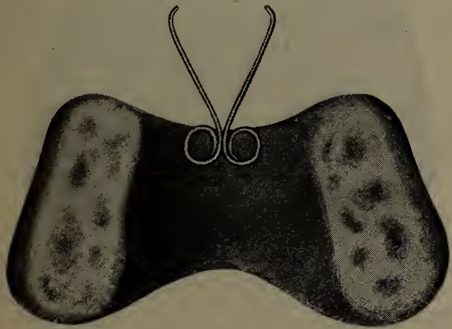

Fig. 239.—Plate for drawing together central incisors.

Fig. 240.—Plate for pushing outwards the distal side of a maxillary central incisor, and at the same time slightly rotating it.

(*c*) *Gold Wire* can be used in place of pianoforte wire for regulating. It may be made fairly springy by gentle hammering,

Fig. 241.—Plate for retracting premolars.

Fig. 242.—Plate for pushing forwards a maxillary incisor.

Fig. 243.—Plate for retaining the teeth in position after regulation.

but the peculiar elasticity of the steel wire cannot be obtained. Gold wire is neater in appearance, does not stain the teeth, and does not oxidize.

(β) **Fixed Apparatus.**—With fixed forms of apparatus the "point of delivery" is obtained by banding two or more of the posterior teeth and fixing to the band the force to be employed. The bands should always be fastened to the teeth with oxy-phosphate cement. Various forms of fixed regulating apparatus are shown in the following illustrations.

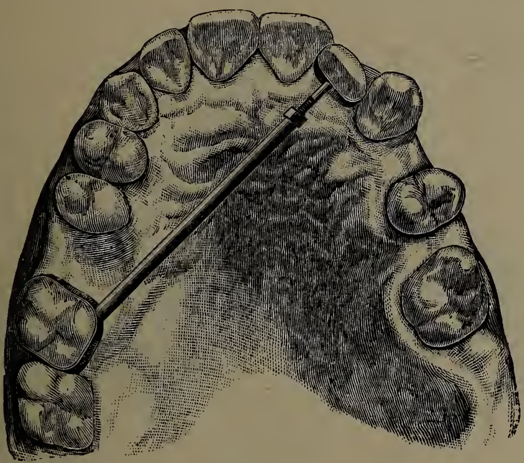

Fig. 244.[1]

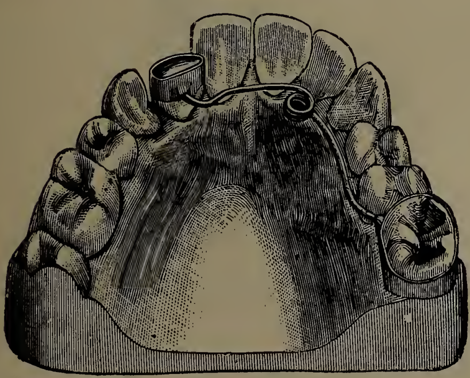

Fig. 245.[2]

In fig. 244 is seen a method (Angle's) for moving a lateral incisor in an outward direction by means of a jack screw. The tooth chosen as anchorage is as nearly as possible in a direct line with the required movement of the lateral incisor.

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[1] From "Mal-occlusion of the Teeth," by E. H. Angle.
[2] From "Text-book of Operative Dentistry." (Kirk).

A method of employing pianoforte wire is shown in fig. 245. The twist given to the wire is generally known as "Talbot's coil."

Fig. 246 shows a method suggested by Angle for retracting a canine. The anchorage tooth and the tooth to be moved are banded. The two bands are connected by a traction screw.

A method of producing rotation, also from Angle, is shown in fig. 247. The tooth to be rotated is banded. Anchorage is

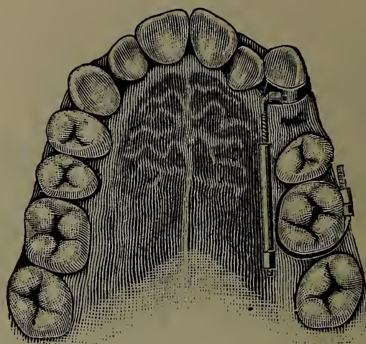

Fig. 246.[1]

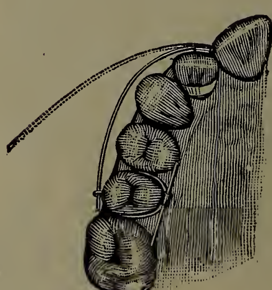

Fig. 247.[1]

obtained from the second premolar, the resistance being increased by the bar shown in the figure. The teeth are then connected by pianoforte wire.

A method of moving forward incisor teeth, designed by Goddard, is shown in fig. 248. The first molars are banded and to the bands tubes are attached into which pianoforte wires are inserted. The wires are bent to conform to the arch of the teeth and their free

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[1] From "Mal-occlusion of the Teeth," by E. H. Angle.

ends are inserted into tubes on the labial surfaces of bands cemented on the teeth to be moved.

A method of retracting a central incisor is shown in fig. 249.

In the type of appliance advocated by W. H. Jackson the anchorage is obtained by spring clasp attachments supporting a base wire to which any form of spring can be added. The clasp is made by bending a thin piece of plate-metal to fit the labial or palatal

Fig. 248.[1]

Fig. 249.[2]

aspect of the tooth (fig. 250). A piece of spring wire about No. 21 (American gauge) is fitted around the neck of the tooth on the opposite side from that covered by the thin metal (fig. 252). The ends of the wire are made to pass over the arch and to rest on the

[1] From "Text-book of Prosthetic Dentistry" (Essig).

[2] From "Text-book of Operative Dentistry" (Kirk).

depressions at the junction with the adjoining teeth, and are then curved down and bent so as to rest on the metal to which it is soldered. The grasping power of this attachment depends upon the elastic properties and strength of the metals used. The spring

FIG. 250.[1]

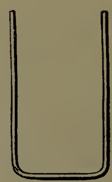

FIG. 251.

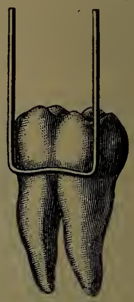

FIG. 252.

FIG. 253.

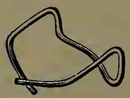

FIG. 254.

FIG. 255.

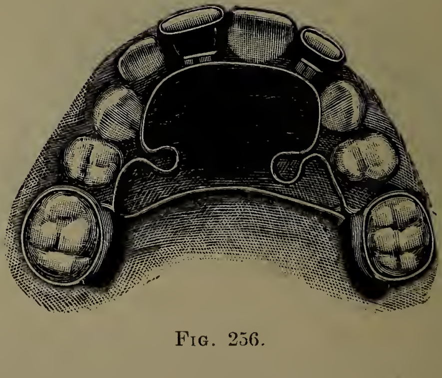

FIG. 256.

clasps are united by a strong base wire, and to this wire are attached the various spring wires required. (See figs. 250 to 255.)

[1] For the use of figs. 250 to 256 I am indebted to Messrs. Lippincott, the publishers of "Orthodontia," by W. H. Jackson.

Fig. 256 illustrates a method of moving incisor teeth outwards. Anchorage is obtained on the first molars. Collars with lugs are attached to the incisors to be moved. The moving force is obtained by soldering a spring to the base bar. The loop of the spring is opened every three or four days. W. H. Jackson claims that his appliances are simple, occupy but little room and can be easily removed and adjusted.

The foregoing examples of mechanical appliances are merely intended to indicate the range of application of the various forces used for the mechanical movement of teeth. Each case must be treated on its merits and the special appliance necessary for each case must be designed by the operator.

The works of Farrar, Angle, Talbot, Guildford, and Jackson contain full accounts of various forms of apparatus favoured by those authors.

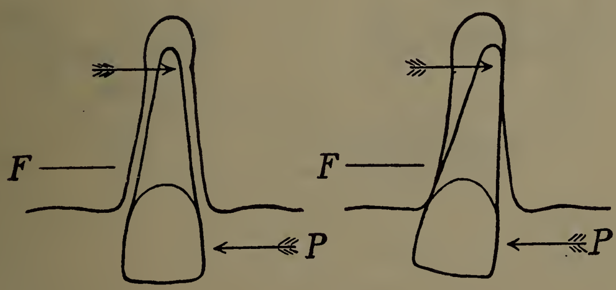

Fig. 257.

Choosing between the Use of Removable and Fixed Apparatus.—In deciding upon the particular apparatus to be used the peculiarities of the case to be treated must of course be considered. Removable apparatus has a distinct advantage in that both the apparatus and the mouth can be easily kept clean. Moreover, with fixed apparatus the adjustment of the bands to the teeth must necessarily entail some damage to the gingival margin even in the most skilful hands, a point of importance in relation to periodontal disease.

(v) **Changes in the Tissues Produced by Mechanical Movement.**—The position which a tooth assumes when acted upon by mechanical appliances depends largely upon the manner in which force is applied.

With the majority of appliances a movement similar to that shown in fig. 257 takes place. The force P, which is applied to

the crown, is transmitted to the opposing portion of the alveolar process F, and in proportion to the resistance here met with, the apex is moved in the opposite direction. The movement of the apex is probably only slight, and for practical purposes **the tooth may be said to move in the arc of a circle** the centre of which is represented by the apex of the tooth.

Under certain conditions it is possible to apply force so as to move both crown and apex in the same direction. The diagrams (figs. 258 and 259) illustrate one method by which this movement

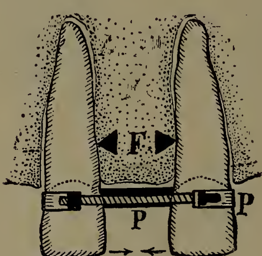

Fig. 258. (Farrar.)

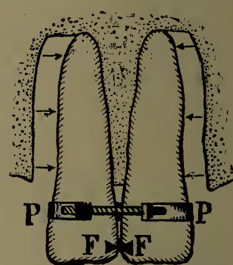

Fig. 259. (Farrar.)

may be produced. If a clamp band is attached to two separated central incisors, the immediate result of applying force will be to approximate the mesial angles and cause the apical portions of the roots to diverge. When the mesial angles come into contact, the fulcrum will be shifted from the alveolus to the point of contact in the crowns and the continued application of force will cause the teeth to approximate throughout their whole length until they become parallel (see fig. 259). It will be noticed that, whilst the alveolar process forms the point of resistance, the apices tend to move in directions reverse from the crowns, but directly the fulcrum is transferred to the crowns the apices commence to approximate. This creation of a static fulcrum on some portion of the crown near the occluding surface and the application of force as high up on the tooth as possible are the fundamental principles underlying all appliances which claim to move the roots of the teeth bodily.

The method introduced by C. S. Case of Chicago is ingenious. The tooth is banded and to the band an upright bar, C, is soldered (see fig. 260). To the lower end of C a traction bar, F, is fixed, this bar being united to the point of delivery. Force is applied by connecting the upper part of the bar C with the point of delivery by means of a bar, P. By adjusting the screws connected with

the bars P and F, the root or the entire tooth can be moved backwards or forwards as required.

When pressure is applied to a tooth, the alveolar wall, against which the pressure is indirectly applied, undergoes absorption; when the tooth has been moved into the position required and is retained there firmly by suitable means, a fresh deposition of bone takes place and a new socket is formed. The rapidity with which this fresh bone is deposited depends upon (1) the recuperative powers of the patient; (2) the retention or non-retention of the tooth firmly in its new position by suitable means during the period the tissue is forming; (3) the amount of local disturbance caused by the operation.

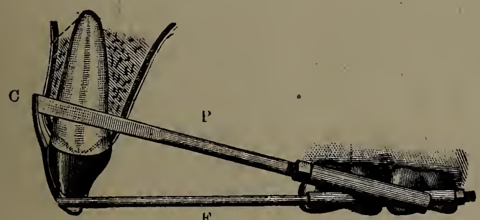

Fig. 260.[1]

(δ) Complications and Sequelæ of Mechanical Movement of the Teeth

(i) **Periodontitis.**—Injury to the periodontal membrane may result from the application of too great a force to the tooth or from direct impingement of the force on the membrane through faulty adjustment. The inflammation of the periodontal membrane may spread to the pulp and so cause death. Chronic periodontitis frequently attacks teeth which have been moved. The changes which occur during regulation may tend to lower the vitality of the tissues and so render them liable to attack.

(ii) **Caries.**—This is to a great extent an avoidable sequela. The cleaner the apparatus and mouth are kept the less will be the liability to caries. Movable types of apparatus have in this respect a decided advantage over fixed types. The mouth and all mechanical appliances must be carefully cleaned after every meal.

[1] From "Text-book of Operative Dentistry" (Kirk).

Before inserting the plate an alkaline mouth-wash[1] should be used, and it is also advisable to run a little of the fluid over the surface of the plate where it comes in contact with the teeth.

(iii) **Permanent Enlargement of the Alveoli.**—This condition is due to inadequate re-formation of bone after the tooth has assumed its new position. There may be a lack of recuperative power on the part of the individual from general causes. Growing tissues are more likely to recuperate than tissues which are fully developed and hence it is that permanent enlargement of the alveoli is frequently met with in cases of regulation in adults. The enlargement of the alveoli may be the result of inflammatory changes in the tissues due to want of care in regulating. Teeth which have been moved should be retained firmly in their new position, otherwise permanent enlargement of the alveoli may result from undue movement in the socket.

(iv) **Injury of the Gums.**—In cases where the regulation has been too rapidly carried out, inflammation of the gums frequently occurs. Inflammation may also arise from want of care in cleansing the plate. The application of a little tincture of iodine, powdered tannic acid, or some other suitable astringent generally removes the trouble. If, however, the inflammation increases, the application of force must be postponed until the gums return to a normal condition.

If, owing to defective adjustment, the plate presses on the gums and not on the teeth, sloughing of the soft tissues may occur. Under these conditions the regulating appliance must be immediately abandoned and must not be used again until the tissues have assumed a healthy condition.

(C) THE MOVEMENT OF TEETH BY SURGICAL METHODS

The immediate regulation of teeth may be carried out by surgical methods. W. H. Dolamore has had extensive experience of this method and suggests the following *modus operandi*:—

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[1] The following is suggested:—

℞ Mag. carb. levis ... ... ʒiv.
Aq. rosæ ... ... ℥vi.
Aquam ad ... ... ℥xii.
M. Shake before using.

After the mouth has been thoroughly cleansed, a tablespoonful is to be taken and moved about in the mouth between the teeth. The magnesia, which is only in suspension, clings about the necks of the teeth and neutralizes any acid. Ordinary solutions of alkalies have only a transient effect upon the oral secretions.

The mouth should be freed from sepsis. Using a modified Hey's saw, with a very thin blade, the gum and alveolar process are sawn through midway between the teeth on both sides and nearly to the apex of the misplaced tooth. The tooth is then moved towards its correct position, the movement being completed by forcing on a metal cap splint made to a corrected model. The splint, lined with cement, fixes the moved tooth or teeth in the new position. It is left on for at least six weeks. The cut is carried through the alveolar process merely for convenience. When moving a tooth outwards the inner alveolar plate does not move. As in immediate torsion a block of gutta percha is used between the blades of the forceps to prevent the tooth from jumping out. A full account of this method will be found in the paper by W. H. Dolamore (*Trans. Odonto. Soc.*, vol. xxxii, p. 42).

So far the methods of treatment have only been described in a general way, and it is now necessary to enter into fuller details as to the methods to be adopted in individual cases. For this purpose irregularities may be divided into clinical groups and the following grouping will be adopted:—

(A) Abnormalities in position of individual teeth.

(B) Abnormalities in position of several teeth—General crowding.

(C) Undue protrusion of the anterior maxillary teeth—Superior protrusion.

(D) Protrusion of the mandibular teeth—Inferior protrusion.

(E) Lack of occlusion—Open bite.

(F) Abnormalities of the teeth associated with congenital defects of the jaw.

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Dolamore, W. H. "The Treatment of Misplaced Teeth by Alveolotomy," *Trans. Odonto. Soc.*, vol. xxxii, p. 42.

Spokes, S. "The Forcible Advancement of In-growing Teeth," *Trans. Odonto. Soc.*, vol. xxvii, p. 180.

Talbot, E. S. "Teeth Irregularities and their Surgical Correction," *Dental Cosmos*, vol. xxxviii, p. 909.

The works of Angle, Farrar, Guildford, and Jackson.

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The chapters on Treatment of Abnormalities in position of the Teeth in "The Science and Practice of Dental Surgery," Edited by N. G. Bennett.

CHAPTER VII

Abnormalities in Position of Individual Teeth

(1) MAXILLARY INCISORS

Separation of the Central Incisors

Causes.—Separation of the maxillary central incisors is usually due to the attachment of the frænum of the lip to the muco-periosteum posterior to the teeth, but occasionally this irregularity can be traced to the presence of a supernumerary tooth; while in rare instances a persistent frænum and a supernumerary tooth are both present. That the frænum acts as a cause of divergent centrals is often overlooked, but that such is the case will be readily seen on an examination of irregularities of this class. In a few cases the cause is obscure, separation being apparently the result of growth of bone at the median suture. Slight rotation often accompanies separation of the central incisors.

Treatment.—Should the cause of the irregularity be removed before the eruption of the canines, the space between the central incisors will, as a general rule, become lessened without mechanical treatment, as the canines in erupting will exert lateral pressure sufficient to bring the incisors into proper position. Supernumerary teeth should therefore be removed, where necessary, at the earliest opportunity and the frænum should be cut.

The operation of dividing the frænum is easily performed as follows: The free edge of the frænum is seized with a pair of artery forceps and drawn forward; a V-shaped piece is then removed from it with a sharp pair of scissors, care being taken to cut the part away where it blends with the gum (a point of great importance). The part between the teeth should also be removed. A strip of lint moistened with boracic acid lotion should be kept between the cut surfaces until the wound has healed, an antiseptic mouth-wash also being given. Cases treated by division of the frænum are shown in figs. 261 to 264. No mechanical treatment was adopted. Division of the frænum, if carried out before the eruption of the canines, will be found to lead to excellent results, but in cases

treated after the eruption of these teeth the benefit is not marked, although the space will tend to close slightly. Should the removal of the cause not prove sufficient to correct the deformity, the teeth can easily be approximated by mechanical methods.

A plate of the form shown in fig. 239 will be found useful. After the teeth have been brought together, it will be necessary to retain them in position by suitable means.

Fig. 261.—Case 1. Before treatment.

Fig. 262.—Case 1. After treatment.

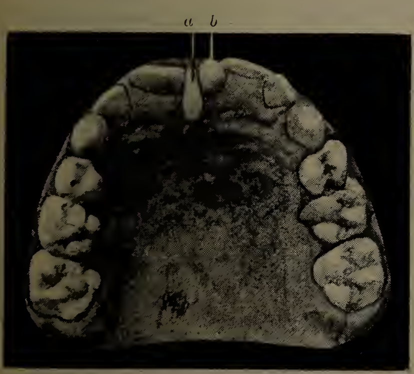

Fig. 263.—Case 2 (semi-diagrammatic). The separation of the centrals was due to (*a*) the frænum, and (*b*) peg-shaped supernumerary tooth.

Fig. 264.—Case 2. After treatment.

Displacement External or Internal to the Arch

Causes.—The displacement of an incisor external or internal to the arch may be due to the persistence of the deciduous predecessor (see p. 139). Where a maxillary incisor erupts so far out of line as to be outside the lower lip, the pressure of the lip will tend

greatly to increase the amount of projection. The protrusion of a maxillary incisor may be due to irregularity of the lower teeth.

Thumb- or finger-sucking, if continued, will lead to protrusion of the incisors.

In a few instances the protrusion is traceable to the habit of constantly sucking the lower lip or tongue. The prolonged use of the baby comforter or "dummy" also leads to protrusion of incisors (see pp. 139 and 239). The presence of supernumerary teeth gives rise to cases of displacement which often present considerable difficulties in treatment. An example is shown in fig. 159.

The supernumerary teeth invariably develop on the palatal aspect of the arch and cause a displacement of the incisors forwards (see p. 109).

Treatment.—Teeth that erupt internal to the arch may be treated either by an upper plate with wires or wedges (see fig. 236), or by a lower plate with an inclined plane. The latter method is particularly useful where the maxillary teeth do not afford a firm hold for a plate.

When a tooth shows signs of erupting external to the arch it is usually sufficient to remove the deciduous tooth and leave the natural forces to complete the process of correction. But if the tooth falls outside the lower lip mechanical measures must be resorted to. After correction, it will be necessary to retain such teeth in position for from three to six months.

Where a supernumerary tooth is the disturbing influence, the tooth should be removed as soon as its presence is detected.

Rotation

Causes.—Rotation of an incisor may arise from the persistence of a deciduous tooth, or from the presence of a supernumerary tooth. A slight tilting of the lateral incisors may often be traced to the canine developing in a slightly abnormal position. The frænum of the lip, in addition to causing separation of the central incisors, may be the cause of slight rotation of one or both teeth. The amount of rotation of the incisors may vary from an eighth to half a turn.

Treatment.—The first step is to remove the cause, if practicable. The rotation of a tooth may be accomplished either by *immediate torsion*, i.e., turning the tooth with forceps, or by *gradual torsion*, i.e., rotating the tooth by mechanical methods.

Immediate Torsion.—This method saves time and avoids a plate, but on the other hand it involves the following risks:—

(*a*) Liability of the tooth to leave the socket (completely) during the operation.

(*b*) The risk of death of the pulp from strangulation of the vessels of the apex.

(*c*) Fracture of portions of the enamel from pressure of the forceps.

(*d*) Fracture of the root in cases where the end is twisted.

As a rule, immediate torsion should not be resorted to until the root of the tooth is complete, which usually occurs about the age of ten. Where there is reason to suspect that the root may be twisted, a skiagram should be obtained with the object of ascertaining its shape.

A model of the mouth should be taken before the operation, the tooth corresponding to the one which is to be rotated being cut off and then re-affixed to the model in the position which it will occupy after rotation. A thin metal splint should next be made, by the corrected model, to cover the lower third of the tooth to be operated on as well as the approximal teeth. This splint is applied by first drying the teeth and then fixing the splint in position with osteoplastic cement.

The operation of twisting the tooth should be performed with a pair of forceps which fits the tooth accurately. The blades should be covered with some such substance as thin lead foil, lint, or cotton-wool. W. H. Dolamore recommends the use of india-rubber between the blades at their division, the elasticity of rubber exerting a force in an upward direction. The tooth should be grasped firmly, and slowly rotated, steady pressure in an upward direction being maintained during the process of turning in order to overcome the tendency of the tooth to leave the socket. It is advisable to turn the tooth slightly more than is required. Immediately the operation is completed, the splint should be applied and retained in place for about a week. An antiseptic mouth-wash should be prescribed.

Before the operation is performed it is obviously essential to obtain sufficient space to allow of the necessary movement of the tooth. At times it is difficult to gauge the precise amount of space that will be necessary, and the direction of the root of the tooth to be turned should always be taken into account, as the tooth will not necessarily occupy the whole space.

Should the accident of complete removal of the tooth from its socket occur, the tooth must be cleansed in an antiseptic solution and replaced. Such teeth frequently remain alive.[1]

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[1] An interesting example of this was recorded by Mr. A. S. Underwood in the *Trans. Odonto. Soc.*, vol. xviii, p. 98.

If the tooth after rotation shows signs of pulpitis, the gum should be painted with a counter-irritant, but if this fails to bring relief and the symptoms become aggravated the pulp cavity should be opened and the pulp removed. It is inadvisable to delay the removal of the pulp, as timely interference may prevent discoloration of the tooth substance, or, what is more serious, suppuration, which may eventually lead to loss of the tooth.

The gradual or mechanical torsion of a tooth can be carried out in a variety of ways, all of which depend upon the principle of two forces working in opposite directions. A favourite method is to fix to the tooth a band with soldered hooks at the mesial and distal angles. Elastic bands are stretched from the hooks to attachments in the vulcanite plate. Other methods might be enumerated, but they all depend upon employing two forces acting in opposite directions.

Elongation

Cause.—Elongation of an incisor is usually the result of an accident.

Treatment.—Where the elongation is slight, the tooth may be cut down by means of carborundum wheels, care being taken to polish the cut surface thoroughly. In more severe cases, an endeavour may be made to force the tooth into the socket if it is desirable to shorten the tooth for æsthetic reasons.

Displacement Upwards of an Incisor

Causes.—This irregularity is generally the result of injury, but it might result from mal-development.

Treatment.—A skiagram should always be obtained in order to ascertain the shape of the root of the tooth. If the root is normally developed and it is considered advisable to correct the deformity, treatment may be carried out:—

(*a*) By reducing the length of the approximal teeth.

(*b*) By bringing the tooth into place with forceps.

(*c*) By gradually bringing the tooth into place by mechanical appliances.

Method (*a*) may be adopted when the displacement is slight, but it is more suitable for the treatment of the central incisors than for the treatment of the laterals. With the central incisors a symmetrical appearance can be obtained by grinding down the cutting edge or rounding off the angles of the fellow tooth. With the lateral incisors reduction of the length of the approximal teeth will naturally give an asymmetrical appearance to the mouth, but

this may of course be overcome by treating the lateral, central and canine on the other side of the mouth in a similar manner, a plan, however, which is seldom advisable.

Method (*b*) may be adopted in cases of forcible displacement upwards, provided that they are seen at an early date after the accident.

Method (*c*) may be accomplished by the plan shown in fig. 265, the suggestion of C. L. Goddard. Caps connected by a wire are

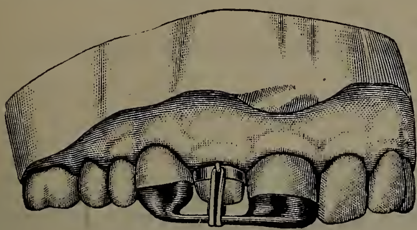

Fig. 265.[1]

attached to the teeth approximal to the one to be regulated. To the latter tooth a band is adjusted, hooks being soldered to the labial and lingual surfaces. Traction force is obtained by an elastic band arranged as shown in the illustration.

Where the root of the tooth is abnormal in direction, method (*a*) only should be adopted.

Total Displacement of the Incisors

Incisors may be transposed, that is, occupy the site of another tooth. For instance, the central and lateral may change positions, or the lateral may occupy the position of the canine. Cases of

Fig. 266.

transposition do not call for treatment. The incisors may be completely displaced, as shown in fig. 266, and it is needless to say

[1] From "Text-book of Operative Dentistry" (Kirk).

that the only treatment for such abnormalities is extraction. Occasionally the incisors erupt high up in the alveolar arch with the cutting edges directed forward. Such teeth are usually "dilacerated," and endeavours to bring them into place would prove futile. Extraction is the only remedy. Niemeyer[1] records a case in which the right maxillary central incisor erupted through the lip in a woman about sixty years of age; and Salter[2] mentions one where the lateral incisor erupted in the nostril.

(2) MANDIBULAR INCISORS

The mandibular incisors may erupt internal or external to the arch. These conditions are usually associated with persistence of deciduous teeth and when this is the case the obstructing tooth should be removed, no further treatment being as a rule necessary. The tongue on the one hand and the lips on the other are usually sufficient to bring the tooth into line. In a few cases the incisor may occlude outside the upper incisor; under these conditions the lower tooth must be retracted or the upper tooth pushed out. Total displacement of the lower incisors is very rare.

(3) MAXILLARY CANINES

The eruption of the maxillary canine external to the arch may be associated with persistence of the deciduous tooth, but as a rule this irregularity is the result of lack of space arising from the forward movement of the premolars and molars. The early extraction of the second deciduous molar may be followed by a forward movement of the first permanent molar, and the second premolar in erupting forces forward the first premolar. If, however, the canine erupts before the second premolar, the first premolar is driven back by the canine and the second premolar erupts in a misplaced position.

Eruption of the canine internal to the arch is usually due to some developmental defect as pointed out on p. 110.

For the methods of treating the above irregularities, see p. 220.

Partial eruption of the canine occurs occasionally. An effort may be made to force the tooth to erupt, but success is by no means certain. An appliance for this purpose is figured by Essig.[3] A band is cemented to the first premolar. To this band a tube is

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1 *Deutsche Monatsschrift für Zahnheilkunde.*

2 "Dental Pathology and Surgery," S. J. Salter, p. 51.

3 "Text-book of Prosthetic Dentistry."

soldered. Into this tube a piece of wire is fixed which extends across the space and under the cutting edge of the lateral incisor. A stud is fixed into the canine tooth and traction applied by means of elastic.

In all cases where a permanent canine erupts late, a skiagram should be obtained, and if there is no indication that the tooth is coming into correct position, or the root shows signs of being twisted, the tooth should be removed and the deciduous canine retained.

Complete Displacement.—The maxillary canine is more frequently "transposed" than any other tooth, that is, occupies the normal position of another tooth. It may be found usurping the

FIG. 267.

place of the lateral incisor, or of the first premolar and occasionally of the second premolar. In one recorded case[1] the left canine erupted posterior to the second premolar, the first permanent molar having been extracted at an early age. The canine is totally displaced from the arch more frequently than any other tooth. The misplaced tooth in these cases often lies dormant and causes no inconvenience, but, should it erupt, extraction is the best remedy. A unique case in which a deciduous canine was developing within the left orbit has been recorded by J. W. Cousins.[2] The patient was two years of age and there was a hard swelling located just within the left orbit.

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[1] Hopewell-Smith, *Brit. Dent. Journ.*, April 15, 1914.
[2] *Journ. Brit. Dent. Assoc.*, vol. viii, p. 294.

On the growth being detached from its surroundings, the crown of a deciduous canine was found enclosed in a sac, the root of the tooth being attached to the orbital plate by fibro-cartilage.

Misplaced canines may lead to troublesome irregularities of the teeth present in the arch. An example is shown in fig. 267. The lateral incisors have been rotated and tilted owing to the pressure of the canines. Under such conditions, the canines must be removed and correction of the misplaced teeth carried out.

(4) MANDIBULAR CANINES

Irregularities of the mandibular canines from causes other than crowding are rare. In the case shown in fig. 177 the deciduous canine is in position and the permanent canine has erupted internal to the arch. The misplaced tooth was removed.

An interesting example of a misplaced mandibular canine was recorded by C. Truman.[1] The tooth appeared under the chin, the presence of a sinus having apparently caused the deviation. After its removal, a premolar made its appearance in the same position. A similar case is recorded by D. Whittles.[2]

Complete displacement of the mandibular canine has been referred to on p. 120.

(5) PREMOLARS

Abnormalities in the position of the maxillary and mandibular premolars are usually the result of early extraction of the second deciduous molar. The first premolar erupts in correct position with the second premolar misplaced internal to the arch. More rarely, both the teeth are involved in the irregularity, as seen in fig. 268. Irregularly placed premolars are best treated by extraction provided that both the approximal teeth can be saved. If, however, one of the approximal teeth is unsavable then it should be removed and the misplaced premolar trained into position. In a case similar to that shown in fig. 268, one of the premolars should be removed, and, in choosing between them, the judgment should be guided by their relation to the opposing teeth and to the degree of rotation.

Misplacement of the premolar may be associated with persistence of the second deciduous molar. An example is seen in fig. 170; in this case the outstanding premolar should be removed. The probable cause of this irregularity was discussed on p. 115.

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[1] *Trans. Odonto. Soc.*, vol. xxiii, New Series, p. 34.

[2] *Journ. Brit. Dent. Assoc.*, December, 1901.

Occasionally the premolars are completely rotated, the external cusp being placed towards the palate. This irregularity is at times symmetrical.

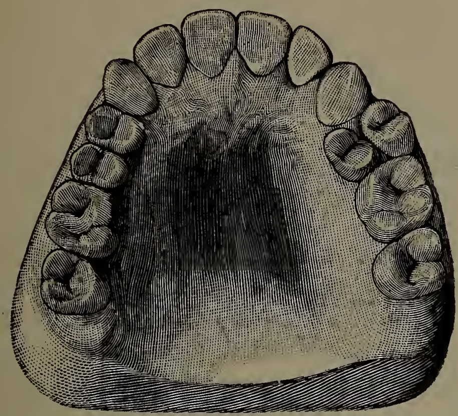

Fig. 268.

Transposition of the maxillary canine and first premolar may occur. Complete displacement of the premolars from the arch is rare.

(6) MOLARS

The irregularities in position of these teeth have already been described on pp. 116 and 122.

CHAPTER VIII

Abnormalities in Position of several Teeth—General Crowding

In general crowding of the teeth the irregularity varies between a slightly crowded arrangement involving all the teeth and the extrusion from the arch of one or several teeth. The causes of the condition are to be found in those factors which, acting subsequent to birth, tend to retard the growth of the jaws, and so diminish the space available for the teeth when erupted. The positions which the teeth assume depend upon several contingencies which may now be conveniently referred to.

Of these, one of the most important is *the position of the teeth in their crypts*. It has already been shown that, even under normal conditions, the permanent teeth are arranged in their crypts in an irregular manner, and it necessarily follows that the irregularity of their position will become more marked as the space available for their development diminishes; the lateral incisors may be placed more inwards and the canines more outwards. The variability of the position of the teeth in their crypts is well shown in the collection of skulls in the Odontological Collection of the Royal College of Surgeons, and a description of the more typical cases has been already given on p. 144. The direction in which a tooth erupts is probably identical with the line of the long axis of the tooth in the crypt, and herein, perhaps, lies the explanation of the frequent eruption of the lateral incisors and the premolars internal, and the canines external, to the arch in cases of crowded mouths.

The Order of Eruption is an important factor in determining the character of an irregularity, and this is clearly shown in cases of early loss of the second deciduous molar. When the teeth appear in normal order the canine erupts after the second premolar; hence, if there is insufficient room in the arch, the canine will be the principal disturbing factor. If there is a fair interval between the lateral incisor and the first premolar the canine will force its way into the arch, causing disturbance in the position of the incisors, but if the interval is slight the result will be the exclusion of the

canine which will erupt in all probability external to the arch. The pressure of the canine will also, in many cases, force the incisors into irregular positions.

Should the canine erupt before the second premolar, the disturbance in the position of the anterior teeth will be less noticeable. The incisors, canine, and first premolar will erupt in a fairly regular manner, the premolar being forced towards the first molar. If the space between these latter teeth is slight, the second premolar will erupt internal to the arch and cause little disturbance. On the other hand, if the interval is nearly normal, the second premolar in erupting will, in all probability, cause displacement inwards of the first premolar and so produce a type of saddle-shaped arch.

The type of irregularity also varies with the cause interfering with the growth of the jaws. In cases where "adenoids" have been present before the age of six the interference with the growth of the premaxillæ will lead to crowding of the lateral and central incisors, the roots of the laterals lying with their apices directed towards the median line. The canine also, owing to the want of development of the anterior nares, will lie too near to the median line, with the result that, when erupted, the root will cover a small portion of the upper part of the lateral root. This point is of practical importance when the treatment of crowded incisors is under consideration.

Where the main interference in the growth has occurred in the molar region, the incisors will generally erupt in a regular curve, and the principal irregularity will be posterior to the premolars and canine.

To thoroughly appreciate the conditions which exist in "crowding of the teeth" it is essential that a careful study should be made of morbid anatomy specimens. Unfortunately our dental museums possess few such specimens, but there is a useful collection in the Museum of the Royal College of Surgeons of England, and from the collection three specimens will be described.

An example of crowding of the anterior teeth in a child aged seven years three months is shown in figs. 269 to 272.

A profile view of the specimen shows that the maxillary central incisors have partially erupted and that they are inclined inwards. It is probable that if the child had lived the upper incisors when fully erupted would have occluded posterior to the mandibular teeth. The maxillary lateral incisors are situated well posterior to the centrals, the canines overlapping their anterior aspects; this is particularly noticeable on the left side.

The palatal view, fig. 271, shows that the premaxillæ are very

FIG. 269.—Skull and mandible showing crowding of the incisor teeth. (Right side.)

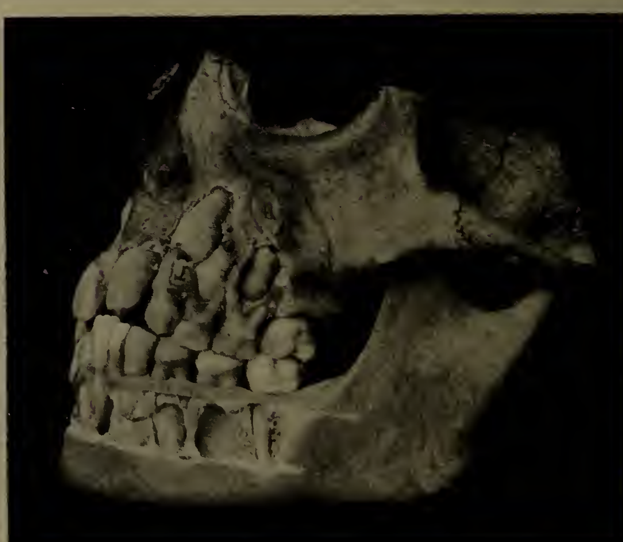

FIG. 270.—Skull and mandible showing crowding of the incisor teeth. (Left side.)

poorly developed and that the anterior part of the palate presents the pushed-up appearance so characteristic of the adenoid palate. The first permanent molars have assumed a normal position in the

Fig. 271.—Palatal view of the specimen shown in figs. 269 and 270.

arch and the second molars appear to have ample room for development.

In the mandible, fig. 272, there is a crowded arrangement of the incisors, the right lateral incisor lying posterior to the central incisor.

Fig. 272.—View of the mandibular teeth of the specimen shown in figs. 269 and 270.

Side views of the jaw are illustrated in figs. 269 and 270. On the left side unfortunately one of the premolars has been lost;

on the right side, however, they are all present so that a good idea can be obtained of the general crowding of the maxillary teeth. The occlusion of the first permanent molars is normal, and there seems to be ample room for the growing premolars. The crown of the first premolar is in close proximity to the lateral incisor and the anterior aspect is in contact with the crown of the canine. The crowding in this specimen seems to be due to lack of growth of the premaxilla.

In the maxillæ and mandible of a male fourteen years of age, shown in figs. 273 to 276, we are able to study the morbid anatomy of a type of general crowding frequently seen in practice.

The general direction of the crowns of the maxillary teeth, fig. 273, is distinctly outwards; the incisors are crowded; the

Fig. 273.—Maxillæ showing general crowding of the teeth.

deciduous canines are still in place; there is clearly insufficient room for the permanent canines; the second molars are partially erupted with the occluding surfaces looking well backwards.

In the mandible, fig. 274, the crowns of the teeth have a decided inclination inwards, the result being that the size of the arch is reduced and there is consequently insufficient room for the canines which are erupting in an abnormal position.

The occlusion of the premolars is normal; the erupting canines are pressing on the distal aspects of the lateral incisors; the maxillary right second premolar has not erupted and is placed in a decidedly abnormal position, the crown being directed outwards. The retarded eruption and irregular situation of the second pre-

molar are probably due to sepsis in connection with the deciduous molar, a carious cavity being present on the mesial aspect. The roots of this tooth show only a slight degree of absorption.

Fig. 274.—View of the mandibular teeth of the specimen shown in fig. 273.

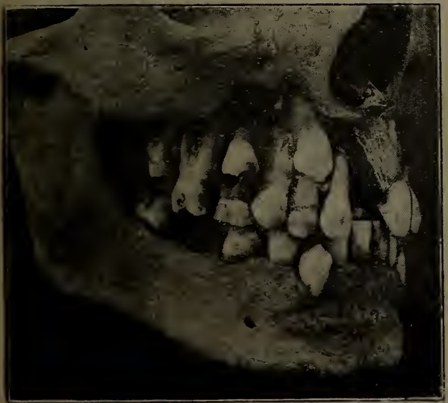

Fig. 275.—View showing the occlusion of the right premolars and molars of the specimen shown in figs. 273 and 274.

Fig. 276.—View showing the occlusion of the left premolars and molars of the specimen shown in figs. 273 and 274.

The irregularity of these teeth is to be traced to the restriction of the area available for their development, caused by the defective growth of the maxillæ after birth. The crowding is most marked

in the incisor and molar regions, that is, the parts of the bone where most growth occurs after birth. The irregular arrangement of the teeth is probably produced in the following manner:—

(*a*) Deficient growth of bone at the suture between the pre-maxilla and maxilla has resulted in (1) diminution in size of the premaxilla, and (2) diminished growth of bone in the region of the deciduous canine.

(*b*) The dwarfed premaxilla has led to a modification in the position of the developing permanent incisors, the lateral incisor being tilted, the root end of the tooth passing towards the middle line.

(*c*) The left central incisor in the process of eruption, owing to lack of space, was deflected slightly to the opposite side, its back-ward movement being resisted by the deciduous lateral incisor.

(*d*) The lateral incisor has erupted in the line of the long axis of the tooth as placed in its crypt, its abnormal direction being subsequently accentuated by the position of the developing canine.

(*e*) The molars, developing in a crowded condition, will have a distinct tendency to move forward when resistance to that movement can be overcome. The loss of the first deciduous molar weakens the resistance and the first permanent molar commences to move forward, pushing before it the second deciduous molar. The first premolars, finding the space for development inadequate, rotate; the right premolar has gained some space by occupying a carious cavity on the mesial aspect of the second deciduous molar. With the loss of the second deciduous molar the resistance to the forward movement is still further reduced, and the first molar takes full advantage of this opportunity to move forward, as the specimen shows. The space between the anterior border of the first molar and the distal angle of the deciduous canine is 14 mm. on the left side compared to 15·5 on the right side. The forward movement of the first molar on the left side has lessened the space for the second premolar, which is being gradually driven internal to the arch.

(*f*) The crowding of the anterior teeth in the mandible is the natural result of the narrow arch in the maxilla. The teeth have been brought into a narrowed arch and have necessarily encroached upon the space for the canines, the last of the successional teeth to appear.

The primary cause of the irregularity seems clearly to be the defective development of the body of the maxilla.

Fig. 277 shows an example of general crowding of the anterior teeth. The arch of the maxillary teeth is distinctly narrow and

the incisor teeth are crowded, the left canine being slightly extruded. The right second premolar and the third molars are missing.

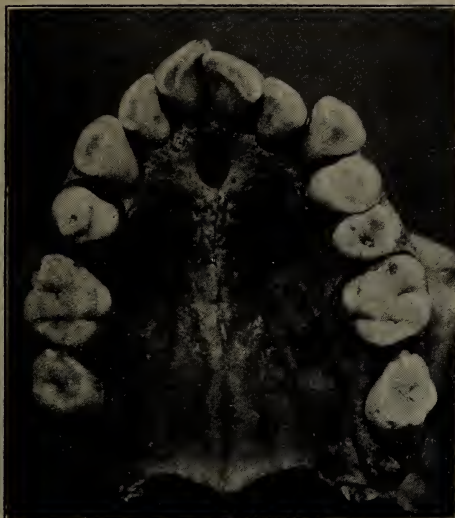

Fig. 277.

In the mandible, fig. 278, the narrowing of the arch has led to the forcing inwards of the left lateral incisor and slight crowding of

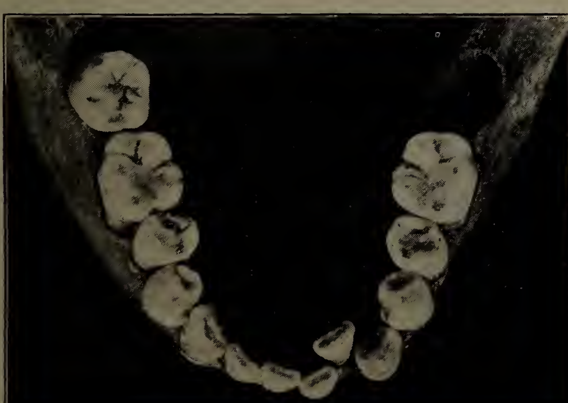

Fig. 278.

the remaining incisors and right first premolar. The third molars are missing.

The occlusion of the teeth is shown in figs. 279 and 280.

On the left side:—

(*a*) The outer cusps of the maxillary premolars and molars are but slightly external to the outer cusps of the mandibular teeth.

(*b*) The crown of the mandibular canine slopes towards the middle line and the cutting edge overlaps the distal angle of the maxillary lateral incisor.

(*c*) The crown of the maxillary canine is directed towards the middle line.

(*d*) The mandibular central incisor strikes against the distal angle of the maxillary central incisor.

On the right side:—

(*a*) The maxillary first premolar and first molar are "flush" with the mandibular teeth.

Fig. 279.—View showing the occlusion of the right premolars and molars of the specimen shown in figs. 277 and 278.

Fig. 280.—View showing the occlusion of the left premolars and molars of the specimen shown in figs. 277 and 278.

(*b*) The maxillary second molar occludes internal to the lower teeth.

(*c*) The crown of the maxillary canine inclines forwards, the distal part of the occlusal margin meeting the anterior part of the lower tooth edge to edge.

(*d*) The crowns of the maxillary incisors slope forwards, the central overlapping the tooth on the opposite side.

Viewed from the anterior aspect (fig. 281) the face displays a general narrowing, the malar process showing a downward curve at its junction with the malar bone. The alveolar process around the anterior teeth reveals definite signs of rarefying osteitis and there is a spur on the septum nasi. These circumstances suggest that the individual was an habitual mouth-breather, and that the

contraction of the arch is the direct result of the muscular tension which is present in this condition.

Treatment.—In considering remedial measures for the treatment of crowding of the teeth, there are important points which should guide us in our choice of method.

Firstly, the prevalence of *caries of the teeth* should be borne in mind, and any method which assists the lodgment of food and increases the difficulty of keeping the mouth clean should, if possible, be avoided.

Secondarily, the increasing liability to lose the teeth from *chronic periodontitis* is a reason for avoiding mechanical methods, in the use of which damage to the gingival margin is so likely to occur.

The main point constantly to be borne in mind is that the

Fig. 281.

crowding of the teeth is the direct result of interference with the growth of the bone and that where the bone is defective in growth the "arch" becomes too small to contain the normal number of teeth. From these premises it follows that, if a regular arch is to be secured, either the jaws must be stimulated to grow or the teeth must be reduced in number.

The latter method can easily be carried out by extraction; but are there any means by which the former can be accomplished? Let us consider this question. It has already been shown that the jaw grows in a backward direction and that the only change in the bone after it is formed is a slight addition from the periosteum, and that that growth is interfered with by lack of proper stimulation. If stimulation is restored, growth continues normally, but this

growth does not occur in the region where the bone is deficient, namely, that anterior to the molar. Indeed, it is difficult to see how any increase in this part can occur without interstitial growth, and there is no evidence to show that such growth occurs.

Some maintain that the jaw can be stimulated to grow and they adopt the method of treatment known as "expansion of the arch." This operation, which was first suggested by W. H. Coffin, consists in moving all the teeth, or some of them, in an outward direction. On a previous page the movement of teeth under mechanical traction was discussed, and it was shown that, with the majority of appliances, the tooth, for all practical purposes, may be considered to swing on its apex. With "expansion of the arch" the crowns are made to occupy a greater arch and thus obtain relief, but the relief does not extend to the apical portions of the teeth, and as the crowded condition is only partially remedied there is a natural tendency for the crowns to relapse to their irregular position.

It is claimed that, if the crowns are kept in normal apposition, the expanding of the crowns will be followed by the expanding of the roots, and further that the movement of the teeth and alveoli stimulates the growth of the defective jaw, and, indeed, of all the bones of the face, and with them the nasal and accessory cavities. It is extremely difficult to understand how this can occur, and the evidence so far advanced by its advocates is far from convincing, especially as it is quite feasible that the improvement claimed to have been made was the result of natural causes.

It is urged against "expansion of the arch" that considerable derangement of the occlusion may result, but those who advocate this method maintain that if derangement occurs it is due to faulty manipulation.

Expansion of the arch may be carried out with either removable or fixed apparatus. The most satisfactory removable appliance is that suggested by J. H. Badcock, which consists of a split vulcanite plate actuated by an expansion screw. The screw device consists of a stout wire, one end of which is threaded and works in a tube, while the other is smooth and turns stiffly in a bearing. Between the threaded and smooth portions is a square boss, and fixed to the outside of the threaded tube is a parallel guide bar. The screwed tube is attached to one half of the plate and the screw in its stiff bearing to the other, the parallel guide serving to prevent rotation of one half of the plate upon the other. The boss is turned by means of a spanner a quarter turn every other day, or, roughly, one revolution per week, a rate which gives satisfactory progress

without the slightest discomfort to the patient. In this way it is possible to calculate the time necessary for a given amount of expansion. It is most important that the screw should work stiffly as otherwise it will slip back. The patient should be warned of this tendency and the faces of the boss should be marked distinctively, e.g., with dots, so that he may be able to detect and report any relapse of the screw. An arrow should be engraved on the plate to indicate the direction in which the screw is to be turned.

The plate is best retained by Jackson cribs, for preference on deciduous molars, the plate being cut to a knife edge on the lingual side.

In cases where the front teeth project a most useful adjunct to the expansion plate is a flattened flexible wire arch soldered to the crib on each side. The separation of the halves of the plate draws the wire tight and exerts backward pressure on the anterior teeth.

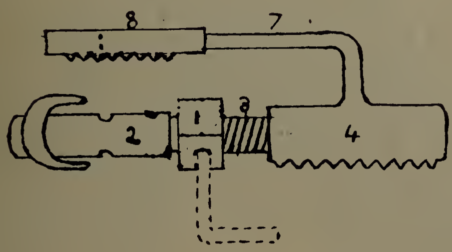

Fig. 282.—A square boss (1) (with tag for holding apparatus in flask) forms the middle of the expansion bar, of which one end is smooth and turns stiffly in a tight bearing (2) (with tag for holding in vulcanite), while the other consists of a male screw (3) engaging with a female screw in a barrel (4) (notched for holding in vulcanite). (7) is a guide bar sliding in the tube (8) (also notched for retention in the vulcanite).

The wire should be furnished with a "U" shaped bend in the vertical plane in the premolar region of each side to allow of adjustment.

The shortening of any of the incisors can be effected by means of flat wires soldered at right angles to the arch and hooked over the cutting edges. It is generally desirable to employ two such hooks in order to prevent the arch from slipping up when tightened.

In Badcock's opinion the three operations of expansion, retraction and shortening can be effected with a plate such as that described above, and as the plate can be easily manipulated by the patient when once it has been accurately adjusted it is specially useful for cases which are withdrawn from skilled supervision for several months at a time, e.g., children at boarding school.

Of fixed apparatus for expansion of the arch one of the most recent types, suggested by E. H. Angle, is shown in fig. 284 and is known as the "ribbon" expansion arch. It consists of a delicate, flat wire (fig. 283), the ends being threaded and provided with

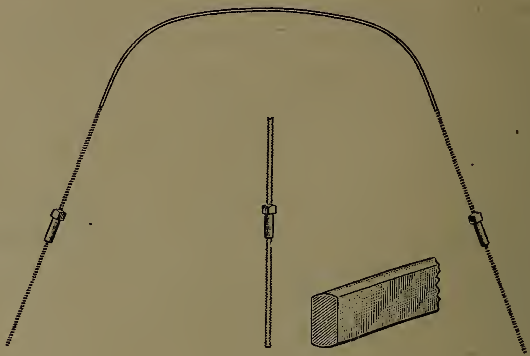

FIG. 283.[1]

friction lock nuts. The teeth used for anchorage are banded and bands are cemented to the various teeth to be moved, to the outside of each band a catch is soldered of the shape shown in fig. 284. The ribbon arch is fixed in position as follows: "One of its screw ends is inserted in the sheath of the anchor band of one of the first

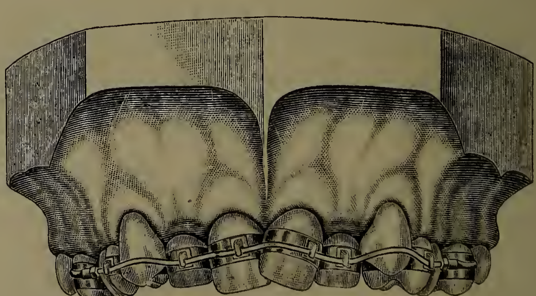

FIG. 284.[1]

molars, and the friction lock nut is seated. The arch is then sprung with the fingers into the slots in the brackets, which it accurately fits, beginning with the one nearest to the first anchor band and proceeding in regular order until the anchor band on the opposite

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[1] From *Dental Cosmos,* September, 1916.

molar is reached, when the second nut is adjusted to approximately its proper position on the arch, but neither the end of the arch nor the friction portion of the nut are at this time placed within the sheath of the anchor band. The arch is then disengaged from all the brackets, but not from the sheath of the first anchor band. Now the screw of the loose end of the arch is slipped into its sheath on the second anchor band, and the nut seated. Then, beginning as before, the arch is replaced in the brackets in exactly its former relation, the last step being the proper seating and accurate adjustment of the second nut in its anchor sheath.

By studying the engraving, fig. 285, it will be easy to understand the manner in which the force is applied to each of the

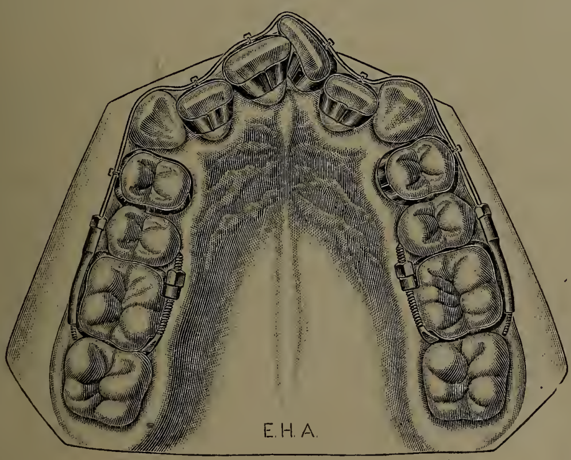

Fig. 285.[1]

malposed teeth in order to effect not only their individual but also their collective movements. The elasticity of the arch, in this special case, operates constantly for the labial movement of the laterals, the torsional movement of the centrals, the buccal movement of the first premolars, and the lingual movement of the canines. And, as there is no waste of power through the slipping of attachments, the movement of the teeth must continue until the force from the elasticity of the arch as then bent has become exhausted, and the arch passive. Force is renewed by removing the arch and bending it to more nearly ideal form, when it is again sprung into place in the brackets and sheaths. By this means the teeth are moved continuously, until finally the ribbon arch has been

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[1] From *Dental Cosmos.*

given the exact form desired for the dental arch, and the teeth, through their bracket attachments, have been made to conform perfectly to it. As the metal of which the arch is made is very elastic, and as the ribbon form permits much greater range of elasticity than does a round arch, the force will be continued for a corresponding longer period before it is necessary to remove the arch and modify its form. Indeed, but two or three modifications during the whole course of treatment would probably be enough in most cases. The force is gently and almost continuously operative in exactly the right direction, without the injurious disturbance of cell function which must follow the use of any mechanism that requires frequent removal and replacement." (Angle.)

The majority of those who favour expansion recommend that treatment should commence soon after the eruption of the incisors, the deciduous second molars being used as anchorage.

It will readily be seen that expansion entails a long period of mechanical treatment, and this is most undesirable from the point of view of the hygiene of the mouth.

It is claimed by those who advocate expansion that with the attainment of ideal occlusion the facial expression is improved, but the improvement claimed is after all a matter of opinion, and in many of the illustrations of cases of expansion there has been a loss rather than a gain in the expression of the features.

In considering the alternative treatment of crowded arches, namely, extraction, the following points can be urged in its favour:—

(*a*) Room is gained for the roots of the teeth as well as for the crowns.

(*b*) Mechanical treatment is minimized and in many cases dispensed with.

(*c*) Isolation of the teeth is often obtained, and this is a point of therapeutic importance in the prevention of caries.

(*d*) The occlusion is but little deranged, provided that the extraction is judiciously carried out.

(*e*) The teeth invariably assume better directions.

In the large majority of cases extraction is far preferable and would appear to be more rational than expansion of the arch.

When employing extraction, it is rarely needful to remove a **central incisor.** Occasionally, the removal of the **lateral incisors** or **canines** is necessary. Generally, a tooth posterior to the canine can be removed and a choice has to be made between the first and second premolars and the first permanent molar.

The removal of the **first premolar** has the advantage of relieving

the crowding of the anterior teeth more easily than the removal of either the second premolar or first permanent molar. Its removal causes little disturbance of the occlusion of the teeth. If, however, the amount of room required is slight, there is some risk of creating too great a space between the canine and the second premolar.

Extraction of the **second premolar** provides less room than removal of the first premolar, but more room than removal of the first permanent molar. The occlusion of the teeth is only slightly disturbed and any space that may result would be between the first premolar and first permanent molar and would be less unsightly than a space between the canine and second premolar. Removal of the second premolar has the advantage of freeing the anterior surface of the molar, and this will lessen the tendency to caries and allow any caries which may exist to be more easily treated.

Removal of the **first permanent molar** gives less room than the removal of the first premolar, or, probably, the second premolar. The treatment necessary is also more prolonged and the occlusion of the teeth is liable to be disorganized, the second lower permanent molars tilting, and the premolars, both upper and lower, rotating. As an organ of mastication the first permanent molar is most important. It possesses the largest area of crown surface and is situated in that part of the arch where the muscles of mastication work to greatest advantage. Its importance as an organ of mastication is so great, and the disturbance to the articulation caused by its removal often so marked, that only when the tooth is unsavable should it be removed for the relief of crowding. Under all other circumstances the choice should lie between the first and second premolars; if both teeth are free from caries, the first should be removed if the crowding is marked; if little space is required the choice should fall on the second premolar.

A combination of extraction with expansion is occasionally useful in cases where the amount of crowding cannot be wholly overcome by expansion, and yet expansion is to some extent desirable.

The Effect of Expansion of the Arch on the Nasal Fossa.— Children suffering from nasal obstruction associated with a contracted arch are often referred by the rhinologist to the dental practitioner with the view of expanding the arch to relieve the nasal stenosis. In justification of this operation it is claimed that the median maxillary suture may be forced open by rapid expansion, the separation of the bones will then allow the septum to

straighten itself and bone growth will take place at the median line, the result being that the floor of the nasal fossa is permanently widened. The claim is supported by appearances seen in skiagrams before and after treatment. But such evidence is extremely unsatisfactory. The distortion of skiagrams of the maxilla is well known, and there is special difficulty in taking two pictures at the same angle which is necessary for such evidence.

In considering whether the nasal fossa may be influenced by expansion of the arch, the anatomical relation of the parts must be first considered. The maxillæ have as lateral abutments the malar processes, the malar bones and the zygomatic arches with their attachments to the sides of the brain cases, and these abutments are still further supported by the pterygoid processes and the vertical plates of the palate bones. They are permanent structures of comparatively hard bone, whereas the bone of the alveolar process is of far softer character. If the maxillæ are forced apart, the lateral abutments must give way, and it is not reasonable to think that they would yield before the softer bone of the alveolar process. It is, however, a clinical fact that in a few cases of marked constriction of the posterior part of the arch nasal respiration is improved by spreading the arch. M. Cryer[1] has suggested a reasonable explanation of this phenomenon. The effect of the narrow arch is to compress the tongue and force it back into the oro-pharynx. "The tongue," he says, "pushes up the soft palate against the pharyngeal wall and cuts off respiration through the nose. As the tongue forces the epiglottis downwards and backwards it also interferes with oral respiration, which, however, is a little easier than nasal respiration under those circumstances, hence 'mouth-breathing.'" Spreading the dental arch gives relief to the nasal obstruction by allowing more room for the tongue which moves forward and releases the pressure on the soft palate and other structures.

Treatment of Cases coming under Observation before the Premolars and Canines have Erupted.—Where crowding is inevitable, treatment should be commenced at an early age. For simplicity of description this question will be considered under two headings: (i) Cases where the first permanent molars are unsavable. (ii) Cases where the first permanent molars are savable.

(i) Where the First Permanent Molars are Unsavable

In these cases good results accrue from a line of treatment somewhat similar to the following: The first permanent molars

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[1] *Items of Interest*, January, 1913.

are filled or treated in the manner best calculated to retain them until the second permanent molars have erupted. The crowding of the upper and lower incisors is then relieved by the removal of the four deciduous canines. If the teeth erupt in the normal way, the first and second premolars will come into good position, and we shall then have the following condition: the four incisors and the four premolars will be in a regular arch with a greater or less space between the lateral incisors and the first premolars so that the canines erupt just external to the arch; in other words, we shall have to deal with a fairly simple irregularity, namely, the canines high in the arch. To make room for the canines, the first permanent molars should be removed directly the second permanent molars are fairly through the gums. A plate to hold back the second molars should then be inserted. This plate (fig. 286) is made to

FIG. 286.

cover the palate so that it comes in contact with the palatal surfaces of the incisor teeth, while to the back of it are fixed half-round gold wires which pass around the anterior and buccal surfaces of the second molars, the plate being quite free of the premolars. This form of plate retains the second molars in position and prevents them from moving forward, while at the same time it allows the premolars to fall back, partly by the action of the bite and partly by the pressure of the canine tooth, so that many cases require no further mechanical treatment—a point of no small importance. Obviously, this line of treatment will not apply in all cases. In some patients, the lower front teeth are so crowded at an early age that extraction of at least one of them becomes necessary. A good

example of this is seen in fig. 287. Here the first permanent molars are quite unsavable, and the crowding of the lower incisors is excessive. This condition is due to pressure from the canines, and removal of the first permanent molars will not sufficiently relieve the pressure to allow the laterals to assume anything approaching a normal direction. If left untreated, the lower canines will, in all probability, erupt in a plane anterior to the laterals. Removal of the right central incisor, however, will relieve the

Fig. 287.

crowding and allow the remaining teeth to assume good directions. The result of treatment is seen in fig. 288 (see also p. 223).

Another example, which could hardly be treated on the general principles just indicated, is to be found in cases where at an early age, it is clear that the maxillary permanent canine will erupt over the position of the lateral. Under such circumstances,

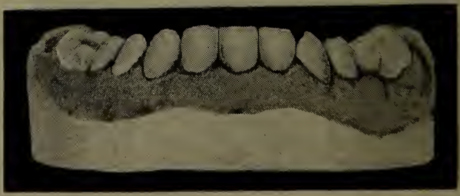

Fig. 288.

the lateral is forced much internal to the bite, or is twisted and turned in some very abnormal position. The lateral incisors must be extracted, and this should be done before the canines erupt. The first permanent molars should be removed before the eruption of the second permanent molars, in order that the latter may move well forward and so fill up the gap caused by the extraction of the first permanent molars. This will prevent undue spacing between the anterior teeth, which would be unsightly.

(ii) Where the First Permanent Molars are Savable

Attention should, in the first instance, be directed to the first permanent molars, and these teeth should be filled in as permanent a way as possible. The probable position of the permanent canine should next be determined. If the incisors are in a fairly regular line, or if the lateral has its mesial angle tilted forward, it may be assumed that the canine will erupt posterior to the lateral. If, on the other hand, the distal edge of the lateral is projected forward, and the apex of that tooth is directed towards the median line, we may conclude that the canine will, in all probability, erupt over the situation of the lateral, and the same may be assumed if the lateral is placed much internal to the bite, and the deciduous canine lies close to the central.

Where the canine shows signs of erupting posterior to the lateral, the treatment must depend upon the degree of crowding. If the crowding is slight, the deciduous canine should be removed and further treatment delayed until the permanent canines show signs of erupting. Either the first or the second premolar should then be removed, the choice depending upon the amount of space required for the erupting canines. In the case shown in figs. 290 to 293 the first premolars were removed immediately the canines showed signs of erupting.

If, however, the crowding of the incisors is marked, the unerupted first premolar should be removed. This operation permits the permanent canine to move backwards and so relieves the pressure on the anterior teeth (see fig. 289).

It may be argued that extraction of the deciduous canine would suffice to remedy the condition of the lateral, but, if the dried specimen be carefully studied, it will be noticed that the removal of the deciduous canine will not provide room for the permanent canine.

In performing this operation, an anæsthetic should always be given, as the removal of the premolar is frequently difficult. Nitrous oxide is quite sufficient if the operation is confined to one side of the mouth; but a longer period of anæsthesia must be obtained if it is necessary to remove both premolars at one sitting. The most suitable instrument for the removal of the teeth is a pair of upper root forceps with rather long blades. The deciduous molar is first removed. In attempting the removal of the premolar, the inner blade of the forceps must be kept well inwards, the blades being thrust well upwards and extractive force made in an inward direction. The occluding surface of the erupting premolar is

directed slightly inwards, and, unless the precaution suggested is taken, the inner blade of the forceps impinges on the occluding surface and does not grip the inner aspect. The after-treatment of the wound consists in the use of an antiseptic mouth-wash.

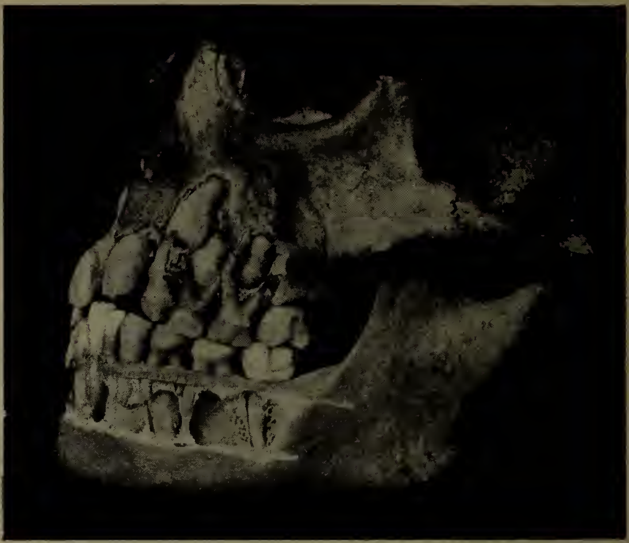

Fig. 289.—In this specimen the lateral incisor is placed internal to the arch with the canine partially covering the labial surface.

Fig. 290.—Upper, before treatment.

Fig. 291.—Upper, after treatment.

Crowded mouths treated in this manner give excellent results. The canine moves into the space previously occupied by the premolar. Pressure on the front teeth is relieved, a good arch is

obtained, and, what is most important, the teeth will be in excellent direction. In addition, mechanical treatment is avoided, and the occlusion of the molars and premolars remains good. Figs. 294 to 296 illustrate this form of treatment. At times, the space in

Fig. 292.—Lower, before treatment.

Fig. 293.—Lower, after treatment.

Fig. 294.—Before treatment. (In this case the lateral incisors had to be pushed forward over the lower teeth.)

Fig. 295.—After treatment.

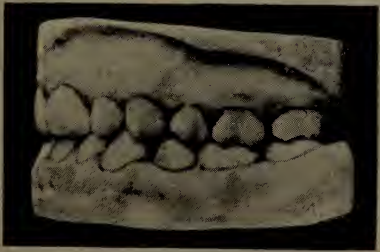

Fig. 296.—Side view, showing occlusion of premolars and molars after treatment.

the arch between the lateral incisor and the first permanent molar is insufficient even for two teeth, a condition shown in fig. 297. In these circumstances, the molar should be retracted until there is room for the canine and one premolar. The molar should then be retained in its new position and the first premolar extracted.

The advantages of the early extraction of the premolars, where a severely crowded mouth is in the future inevitable, are:—

(1) Pressure on the front teeth is relieved and any irregularity of position which they may have assumed is easily rectified.

(2) The canines and premolars come down in a good direction and form a regular arch.

(*a*) (*b*)

Fig. 297.—(*a*) before retraction of the first molar; (*b*) after retraction of the first molar.

Where the canines show signs of erupting over the situation of the laterals, little advantage is gained by the removal of the premolars, and the more satisfactory treatment in such cases is to remove the lateral incisors before the canines erupt. Cases treated in this way are shown in figs. 298 to 301.

Treatment of cases coming under observation after the premolars and canines have erupted:—

(i) Crowding complicated by Disease of a Central Incisor.— The treatment of such cases must depend upon—

(*a*) The prospect of permanently retaining the affected tooth.

(*b*) The degree of crowding.

(*c*) The sex of the patient.

(*d*) The age of the patient.

If the pulp of the central incisor died after the root was complete there is a reasonable prospect of saving the root and crowning

it, provided that no serious periodontal trouble supervenes. Under these conditions, the tooth should be saved and the crowding treated by the removal of a posterior tooth. But if the pulp died before the completion of the root the tooth should be removed.

The question whether the space left by the removal of the tooth should be allowed to close up must be decided according to the

FIG. 298.—Before treatment.

FIG. 299.—Case shown in fig. 298. After treatment.

FIG. 300.—Before treatment.

FIG. 301.—Case shown in fig. 300. After treatment.

merits of each case. With a boy, especially if there is considerable crowding as shown in fig. 302, the space should be allowed to close up in order to avoid the necessity for an artificial denture—a point of importance as far as the hygiene of the mouth is concerned. The unsightliness can usually be hidden to a great extent by a

moustache in later life. With a girl, the disfigurement is of more serious import, and the space should therefore be retained by suitable means, an artificial denture being subsequently inserted.

FIG. 302.

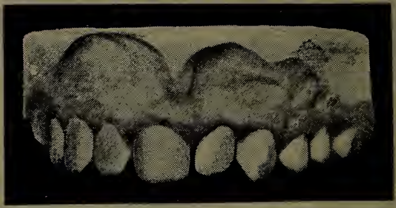

FIG. 303.—The case shown in fig. 302. After treatment.

FIG. 304.

(ii) Crowding which has resulted in the Protrusion of a Central Incisor.—An example of this irregularity is shown in fig. 304. The

patient was aged 21. The arch was expanded and the projecting incisor retracted. The result of the treatment is shown in fig. 305.

(iii) Crowding which has resulted in the Exclusion of Laterals from the Arch.—The advisability of sacrificing a lateral incisor in

Fig. 305.

the treatment of crowding is constantly disputed, some practitioners even going so far as to maintain that, under no circumstances, can the adoption of such a course be defended. The principal argument urged against the removal of this tooth is that the canine erupts

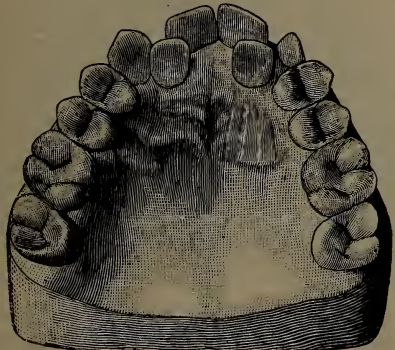

Fig. 306.

next to the central and produces an unsightly appearance. It is true that a lateral in correct position has a better appearance than a canine next to the central, but where the extraction of a lateral is in question, the problem to be solved may be set out as follows:

Is it better to have a canine in correct alignment next to the central and the premolar in apposition to the canine, or a lateral in a maldirection, with, possibly, its cutting edge tilted forward and the canine sloping towards the median line, and, in all probability, short. For example, consider the case shown in fig. 306. The laterals are displaced inwards to a considerable extent and are in a vertical direction, the canines being but slightly external to the arch. An examination of the roots of the teeth shows the canines to be sloping towards the median line, while the roots of the first premolars take the same direction. Extraction of the laterals will

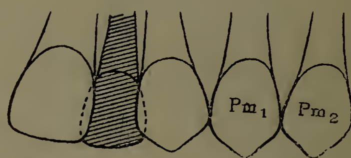

Fig. 307.—Case before treatment, showing positions of incisors and canine.

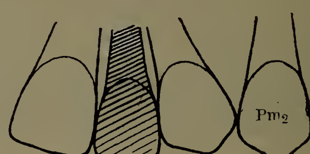

Fig. 308.—Result of treatment after removing the first premolar.

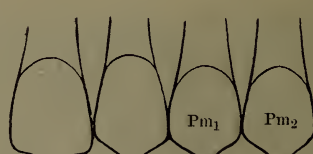

Fig. 309.—Result of treatment after removing the lateral incisor.

effect a remedy without mechanical treatment; the canines will come down in good direction, the centrals will fall back and assume a more correct position, while the premolars will move forward also into a vertical position. If an attempt were made to treat the case by extraction of the first premolar, the result obtained would, in all probability, be far from satisfactory. Even with a fairly good result, and with the teeth brought approximately into a normal curve, the difference in the slope of the teeth would produce anything but a pleasing appearance. The central would be forced more outward, the lateral would have its cutting edge directed forward,

that is to say, the neck of the tooth would be in a plane well posterior to the central, the cutting edge of the canine would be above the level of the lateral, and the slope would be considerable. Further, this operation would entail prolonged mechanical treatment with all its attendant troubles.

A row of teeth in correct alignment with the canine next to the central is more sightly than a row of teeth in bad alignment with the lateral next to the central; and, moreover, it must not be

FIG. 310.

FIG. 311.

forgotten that the public do not view the teeth with the critical eye of the practitioner. Diagrams illustrating these points are shown in figs. 307 to 309.

A case calling for the removal of the laterals is shown in fig. 310.

The cases which test the judgment most are those where the root of the canine is directed only slightly towards the median line

and there is a possibility of the tooth coming into good direction if the premolar is removed. Under these conditions, the removal of the premolar would be the wiser course, especially if the patient is a girl.

Sometimes the laterals are misplaced to such an extent that their extraction is imperatively called for and the first permanent molars are also quite unsavable. Under such conditions, the molars must be removed, if possible before the second permanent

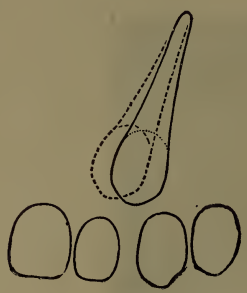

FIG. 312.—Showing the root of the canine lying over the. premolar. The dotted lines represent the direction the canine will take if the lateral is extracted.

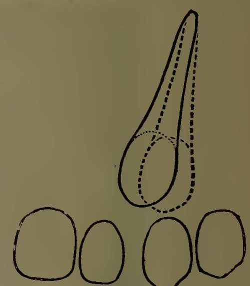

FIG. 313.—Showing the root of the canine lying over the premolar. The dotted lines represent the direction the canine will take if the premolar is extracted.

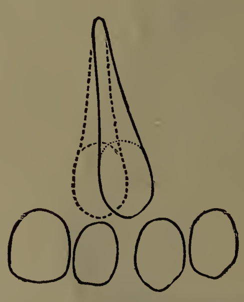

FIG. 314.—Showing the root of the canine lying over the lateral. The dotted lines represent the direction the canine will take if the lateral is extracted.

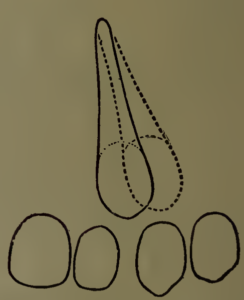

FIG. 315.—Showing the root of the canine lying over the lateral. The dotted lines represent the direction the canine will take if the premolar is extracted.

molars erupt, the latter will then come forward and, in a great measure, prevent a backward movement of the premolars, which would probably leave unsightly spaces between the front teeth.

(iv) Crowding which results in the displacement of the Canine

either External or Internal to the Arch.—The displacement of a canine external to the arch is the commonest result of a crowded condition of the teeth. A typical example is shown in fig. 311.

In dealing with this irregularity, the importance of the canine in the dental arch should be borne in mind. It is the longest and probably the strongest and most highly developed tooth in the arch in which it forms a kind of keystone. It assists to give character to the face; and its extraction leaves a depression near the ala of the nose and in a measure robs the face of expression. For these reasons it should be retained whenever practicable. The choice of treatment usually lies between the removal of the canine, or, alternatively, the removal of the lateral, a premolar, or the molar. The removal of the canine should be regarded as the last resource.

Before selecting the tooth for removal the position of the root of the canine should be ascertained. If the root has a direction forward, the removal of a posterior tooth will cause the canine, when it erupts, to slope backwards to such an extent as to present an unsightly appearance, whereas if the lateral is extracted the canine will erupt fairly straight. If the root of the canine is directed backward a premolar or molar should be removed. The figures 312 to 315 illustrate these points.

Irregularities of the canines seldom require mechanical treatment, especially if extractions have been made with due regard to the bite. Nature will frequently overcome the difficulties unaided, and it is usually advisable to postpone further treatment for a period of from three to six months after extraction, but if the tooth does not then appear to be moving into position, mechanical assistance should be given, and one of the simplest methods in vogue is that shown in fig. 237.

In removing a premolar for the relief of a crowded canine attention must be given to the position of the corresponding lower premolar, for the latter may be placed in such a position as to prevent the upper canine from coming correctly into line. In certain cases, however, extraction of the canines is quite justifiable, especially where, with the arch regular and the occlusion good, the laterals are fairly close to the premolars and the canines erupt outwards almost at right angles, as seen in fig. 316.

(v) Crowding which results in Displacement of Premolars.—Displacement of the second premolar internal to the bite frequently results from crowding. When this occurs, the second premolar has erupted after the canine. Fig. 317 is an excellent example of this type of irregularity. The treatment would be the removal of the abnormally placed premolars, but if the molars are unsavable, it

would be necessary to remove them and bring the premolars into the line of the arch.

(vi) Crowding which results in the Displacement of a Mandibular Incisor.—An irregular arrangement of the mandibular incisors caused by crowding is not uncommon, the canines being mainly

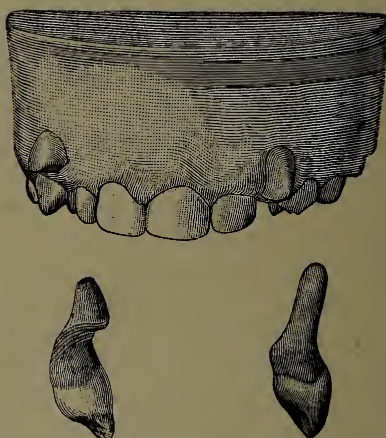

Fig. 316.

Fig. 317.

responsible for the irregularity. The canines are normally developed external to the incisors, the crowns often slightly overlapping the labial surface of the laterals, and where there is insufficient room for their development, the canines encroach on the incisor region and so cause irregularity.

Crowding of the anterior lower teeth is not so important from an æsthetic point of view as crowding of the anterior upper teeth. The most effective treatment when the crowding is severe is to remove an incisor. In selecting the incisor to be removed, the following points should be considered:—

(*a*) A central should, if possible, be extracted in preference to a lateral for reasons of symmetry. If a lateral incisor be removed, the canine on one side will be adjacent to a central, and on the other side to a lateral.

(*b*) An outstanding tooth should be removed in preference to one instanding, as the latter will be more easily brought into correct line, the pressure of the tongue being more powerful than that of the lower lip.

Fig. 318.

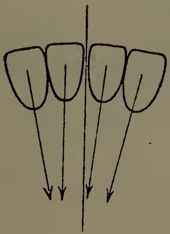

Fig. 319.—Diagram showing directions of the roots of the incisors.

(*c*) The direction of the roots of the different teeth is important. The tooth selected should permit of the remaining incisors assuming a vertical direction. For instance, in the case shown in figs. 318 and 319, removal of the right central incisor would allow the remaining teeth to assume vertical directions, but removal of the left central incisor would result in the right central incisor assuming a distinct slope.

(vii) Mandibular Canines.—Displacement external and internal to the arch may occur, the former being more common. The principles of treatment are similar to those for maxillary canines.

The removal of a mandibular canine does not mar the expression of the features to the same degree as the removal of the maxillary canine. The mandibular canine should be removed in those cases, where it is much external to the arch with the first premolar and lateral incisor in good alignment.

(viii) Mandibular premolars placed external or internal to the arch, see fig. 320, require removal.

General Crowding—Treatment of Cases involving the Malposition of Several Teeth.—The treatment of general irregularity of the teeth will depend, to a great extent, upon the general condition of the teeth. If the first molars are unsavable their removal is indicated, but opinions differ as to the proper time to remove these teeth in order to obtain the best results. From examination of mouths in which there is an absence of crowding of

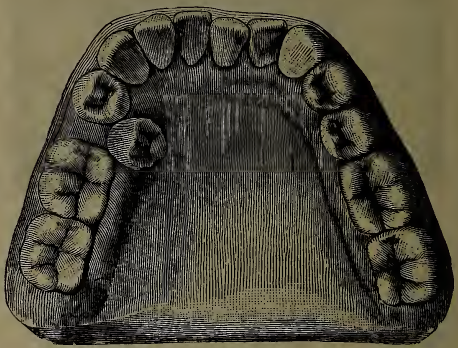

Fig. 320.

the teeth and in which this operation has been performed, it would appear that the best results are obtained when these teeth are removed before the eruption of the second permanent molars, and after the eruption of the premolars. Under such conditions, good spacing between the anterior teeth is obtained and there is far less tilting of the second lower molars (fig. 321). A strong objection to removing the first permanent molars at this period, in cases of crowding, is that the second permanent molars (especially the upper) move forward and encroach on the space required for the backward movement of the anterior teeth. In cases where crowding of the teeth is present the extractions should be delayed until the appearance of the second permanent molars. Many practitioners advise postponement of extraction until these teeth are fully erupted and in good occlusion in order to minimize the tilting of the second lower molars, but if the operation is thus

delayed the crowding will be less easily remedied, as the teeth will have become more firmly planted and the irregularity of the anterior teeth more pronounced. On the whole therefore it seems advisable to remove the first permanent molars as soon as the second molars are sufficiently through to allow of the application of mechanical

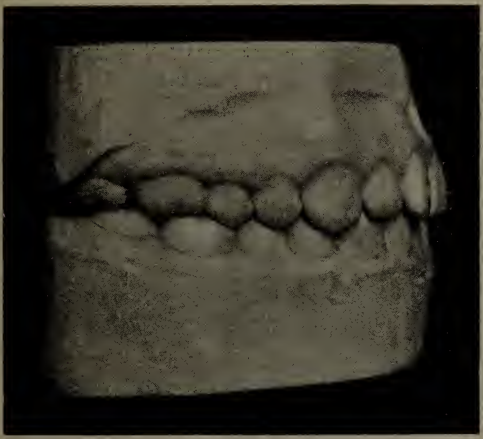

FIG. 321.—Models of a case in which the first permanent molars were removed for caries before the eruption of the second molars.

FIG. 322.—Before treatment.

FIG. 323.—After treatment.

means for holding them back (see fig. 286). In this way the crowding can be relieved at an earlier period, and the tilting of the second molars, to a great extent, prevented.

The ill effects of removing the first molars, in cases of crowding, before the second molars erupt is seen in figs. 322 and 323.

A certain number of cases come under treatment in which the

mandibular first molars have already been removed and no attention has been paid to the maxillary teeth. The following case is instructive[1]:—

Owing to the removal of the lower first molars a year previously, the second permanent molars have travelled forward and partly articulate with the first upper molars; the upper left second premolar is displaced inwards, but otherwise there is practically no crowding (see figs. 324 to 330). Some of the upper incisors have been attacked by caries on the approximal surfaces. The left upper first molar has a cavity on the masticating surface, while in the right upper first molar a cavity has been successfully treated on the anterior surface.

The occlusion of the teeth on the right and left sides is diagrammatically shown in figs. 325 and 326.

Fig. 324.

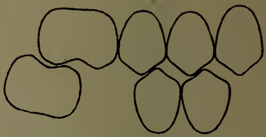

Fig. 325.—Right side.

Fig. 326.—Left side.

On the left side it will be noticed that the second upper premolar is internal to the arch. The articulation between the first upper premolar and the lower premolars is not good. The upper first molar is prevented from moving forward by the second premolar and is only half opposed, while its posterior cusps prevent the second lower molar from moving forward. The second upper molar is erupting, hence a posterior force is present. Extraction of the second premolar will allow the first upper molar and the second lower molar to move forward, and so lead to an improvement in the articulating surface. On the right side it will be seen that the anterior plane of the first upper premolar only partially articulates with the posterior plane of the corresponding lower tooth, and not at all with the anterior plane of the second lower premolar as it should do. Only half the anterior plane of the second upper premolar is used. The first upper molar is only partially in occlusion with the second lower molar and this prevents the latter moving forward. The upper second molar is erupting. Extraction of the second upper premolar would permit the first upper premolar to move backwards

[1] The following cases are fully described with the view of showing the various points to be considered when adopting extraction for the relief of crowded conditions of the mouth.

and articulate correctly with the lower premolars. The first upper molar and second lower molar would move forward and the articulation would be improved. The upper second premolars were removed and the result is seen in figs. 328 and 330.

Where there is marked crowding in the maxilla, with the maxillary first molars savable and the mandibular first molars unsavable, the best results are to be obtained by removing the

Fig. 327.—Before treatment. Right side.

Fig. 328.—After treatment. Right side.

Fig. 329.—Before treatment. Left side.

Fig. 330.—After treatment. Left side.

mandibular first molars before the eruption of the second molars. The latter will then come forward and articulate well with the upper teeth. The first maxillary premolars should be removed, if possible, before the canines erupt. In this way, the crowding of the upper teeth can be correctly overcome and a good articulation obtained. A case thus treated is shown in figs. 331 to 334.

Second premolars should, as a rule, be removed where the crowding is not great. Should a space remain, it will not be so noticeable as if the first premolar had been extracted. Removal of the second premolars is indicated where caries is present on the anterior approximal surfaces of the first molars.

The following is an instructive case requiring the removal of the second maxillary premolars:—

The patient was a girl aged 15. The upper front teeth were crowded and irregular (fig. 335). The lower teeth presented a good arch. An examination of the premolar and molar occlusion on the right side showed that only portions of the posterior planes of the first and second premolars were in contact with the lower teeth (fig. 337). This is diagrammatically shown in fig. 341. Removal of the first upper premolar would allow the second premolar to come forward and occlude with both lower premolars and at the same time allow room for the canine to move backwards, but the second

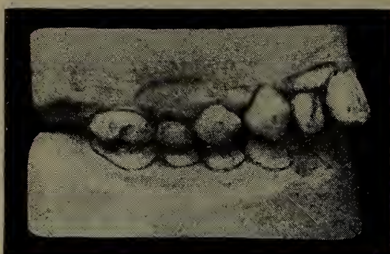
FIG. 331.—Before treatment. Right side.

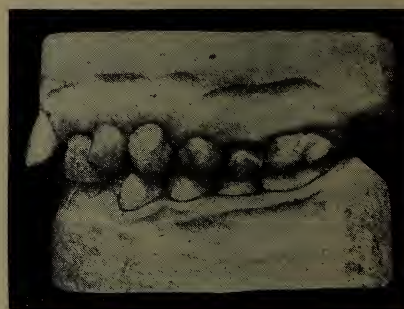
FIG. 332.—Before treatment. Left side.

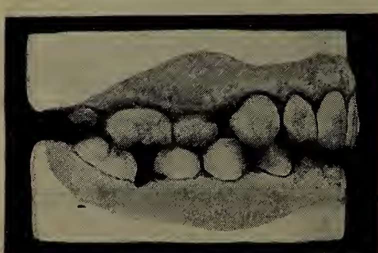
FIG. 333.—After treatment. Right side.

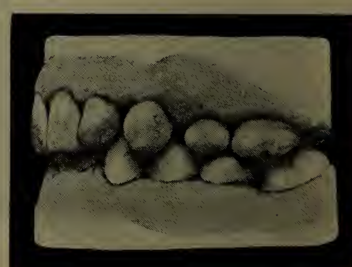
FIG. 334.—After treatment. Left side.

premolar on this side was carious. With removal of the second premolar the first premolar could be brought back and made to articulate satisfactorily with the lower premolars and the crowding of the front teeth would be overcome. On the left side (fig. 339) the second lower premolar had not erupted, and there were no signs of its presence. The second upper premolar, therefore, formed but a small portion of the masticating area and was consequently the tooth to remove.

The treatment consisted in the removal of the second upper premolars. The first premolars were then brought back by mechanical means. A vulcanite plate capping the molars and premolars was made, half-round gold wires being attached to the sides and arranged so as to bring pressure on the

Fig. 335.—Before treatment.

Fig. 336.—After treatment.

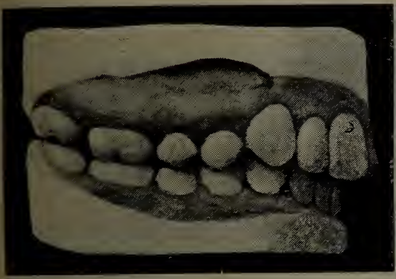

Fig. 337.—Before treatment.

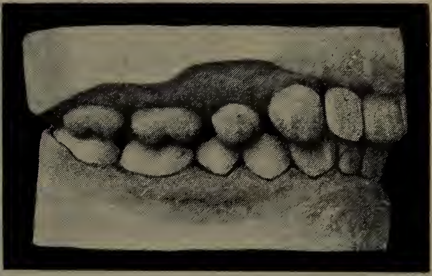

Fig. 338.—After treatment.

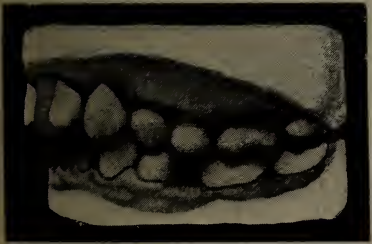

Fig. 339.—Before treatment.

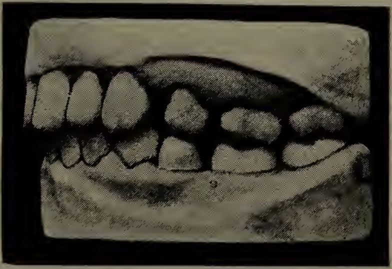

Fig. 340.—After treatment.

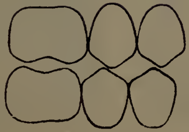

Fig. 341.

mesial angles of the right central and the left lateral. Opposite the palatal aspect of the left central, a wedge of compressed wood was inserted and the tooth brought forward. By a similar arrangement, the distal angle of the right central was driven forward. A retention plate was used for twelve months. The result is seen in figs. 336, 338, 340. A regular arch has been obtained. The occlusion of the teeth on the right side has been improved. On the left side, the occlusion has not been impaired and will be improved when the molars move forward.

In a few cases the removal of a lateral incisor on one side and a premolar on the other may be necessary. The following is an example:—

In this patient, a girl, the anterior upper teeth were crowded, the lateral incisor on the left side being internal to the arch (fig. 342). In the lower, the arch was regular, but the lower central incisors were absent. The teeth were free from caries. An examination of the roots of the left central and lateral incisors and canine showed that the root of the central sloped in a backward direction and was placed in a plane anterior to the root of the lateral and also overlapped that of the right central. The direction of the canine root was very slightly backward and was also in a plane anterior to the lateral. The positions of the three teeth are shown in fig. 343A. The occlusion of the premolars and molars was good (fig. 344). On the right side, the root of the canine was directed backwards, and the crowding of the central and lateral incisors was slight. The relation of the upper to the lower premolars and molars is shown in fig. 346. In considering treatment, the main difficulty was the marked crowding on one side and the slight crowding on the other. On the left side, two courses were open: (*a*) the removal of the first premolar, or a tooth posterior; (*b*) the removal of the lateral incisor. If removal of the first premolar were carried out, the canine would need to be retracted and the lateral incisor pushed out. This operation would probably result in the canine assuming a very sloping direction and being short, the lateral having its cutting edge tilted forward, while the central would be driven still more across the median line. In addition, the treatment would require the prolonged use of a plate, and there would be a constant tendency to relapse. On the other hand, removal of the lateral incisor would permit the central to fall back and assume a more vertical direction and the canine would move forward and fill up the gap. There would be true relief of the crowding (both roots and crowns), and no tendency to relapse. On the right side, but little room is required, and removal of the lateral to correspond with removal of the left lateral is out of the question. The treatment, therefore, resolves itself into the removal of a premolar or a molar. The molar is free from caries, so a choice must be made between the first and second premolars. Removal of the first premolar would, in all probability, result in a gap between the canine and the second premolar. Removal of the second upper premolar alone, and retraction of the first premolar would also leave a gap, because the first premolar would eventually occupy the same position as the second premolar. Removal of the lower second premolar as well as the upper second premolar would allow the first premolars, upper and lower, to move back sufficiently to overcome the crowding of the incisors and canine, while the molars would move forward and assist in filling up the gap. In addition, mechanical methods would be avoided. Treatment

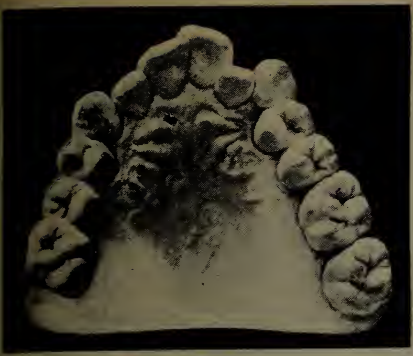

Fig. 342.—Before treatment.

Fig. 343.—After treatment.

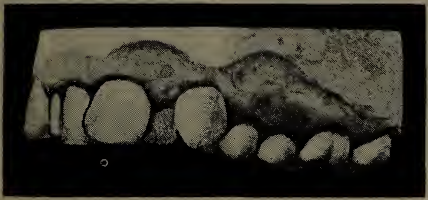

Fig. 343a.

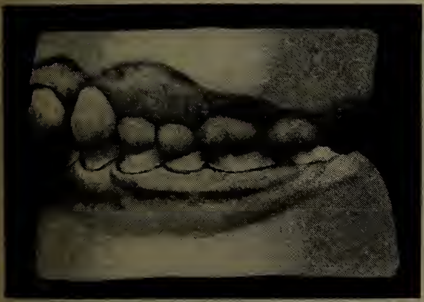

Fig. 344.—Left side. Before treatment.

Fig. 345.—Left side. After treatment.

Fig. 346.—Right side. Before treatment.

Fig. 347.—Right side. After treatment.

consisted in the removal of the left upper lateral incisor and the right upper and lower second premolars. The result of treatment is seen in figs. 343, 345 and 347. On the right side, a slight gap has resulted between the premolar and canine, but when the case was last seen the molars had moved still more forward and had considerably improved the occlusion of the upper premolar with the lower premolar and first molar. With the advent of the third molars, the space will, no doubt, be entirely closed.

The operation of expansion may be adopted in cases where the general lie of the premolars and molars is inwards, and where the

Fig. 348.—Before treatment.

Fig. 349.—After treatment.

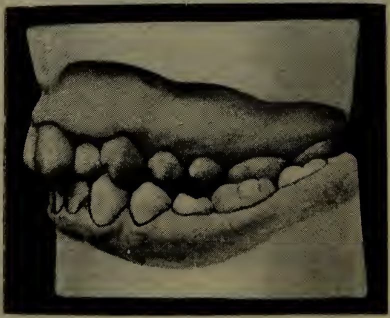

Fig. 350.—Before treatment.

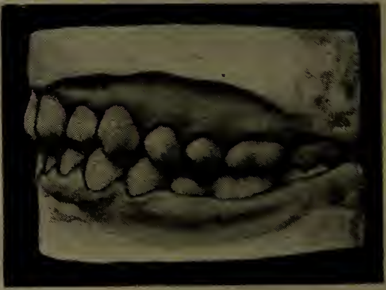

Fig. 351.—After treatment.

articulation and the personal appearance of the patient will be improved by the operation. A case treated by expansion is shown in figs. 348 to 351.

Figs. 352 to 354 are the models of a case of crowding of the teeth under the care of G. Northcroft, which he treated by means of expansion. The child was breast-fed for three months and then hand-fed, a boat-shaped bottle

Fig. 352.—Before treatment.

Fig. 353.—After treatment. The second permanent molars have erupted.

being used. No adenoids. The first models of this patient were taken at the age of 8 years 4 months, and showed slight crowding of the upper and lower anterior teeth. As the condition did not improve and the occlusion was getting worse, it was decided at the age of 10 years 9 months to adopt

operative treatment. From the models shown in figs. 356 and 358, it will be noticed that the molar occlusion is correct on the left-hand side, but on the right-hand side the upper molar is in advance of its normal position and presents a flush occlusion. The treatment consisted in applying expansion

Fig. 354.—Before treatment. The second molars have partially erupted.

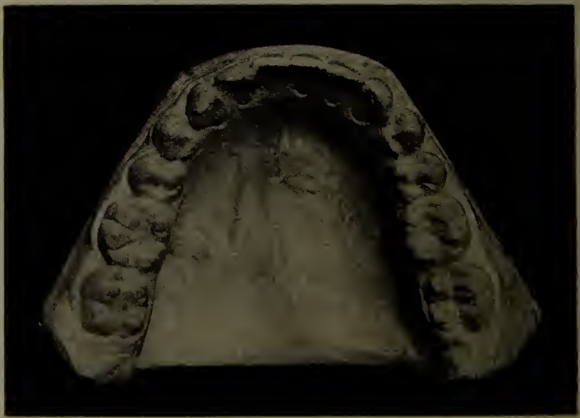

Fig. 355.—After treatment. The second molars have completely erupted.

arches to the upper and lower teeth, combined with inter-maxillary reciprocal traction. Pressure was brought to bear on the first maxillary molars, and a band and spur applied to rotate the left upper lateral. At the end of a little over four months, the appliances were removed and vulcanite retention plates inserted. The models, shown in figs. 353, 355, 357, and 359, represent the case a year and three months after completion of treatment.

The following are the comparative measurements of the case when seen at 10 years 9 months and when completed :—

	10 yrs. 9 mths.	Completion of treatment
Width between $3 \mid 3$ at tips	35·5 mm.	37 mm.
,, ,, $4 \mid 4$,, gum-line	24·6 ,,	27 ,,
,, ,, $5 \mid 5$,, ,,	30·5 ,,	33 ,,
,, ,, $6 \mid 6$,, ,,	36 ,,	38 ,,
Depth of palate at $6 \mid 6$ from gum-line	11 ,,	15 ,,
Length of jaw from palatal sulcus of molar to 1 1	35 ,,	36 ,,
The combined distances between $4 \mid 4$ and $2 \mid 2$ are	6·5 ,,	12·9 ,,

The average expansion being about 2 mm.

Fig. 356.—Left side before treatment.

Fig. 357.—Left side after treatment.

FIG. 358.—Right side before treatment.

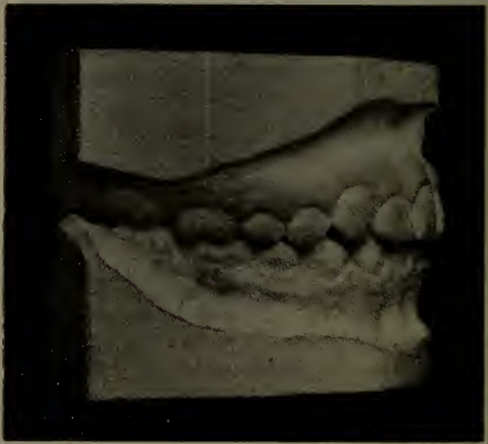

FIG. 359.—Right side after treatment.

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CHAPTER IX

Abnormalities of the Teeth (*continued*)

Superior Protrusion—Inferior Protrusion—Lack of Occlusion

ABNORMALITIES DUE TO CONGENITAL DEFECTS OF THE JAW

(A) SUPERIOR PROTRUSION

The term "superior protrusion" is applied to that type of irregularity in which the maxillary front teeth project abnormally. In most cases of superior protrusion the upper teeth project beyond the lower lip which passes behind them and, the upper lip failing to cover them, they remain partly or wholly exposed.

(1) *Etiology and Pathology.*

Cases of superior protrusion may be divided into groups, each of which possesses clearly defined characteristics.

Group 1.—The jaws are well developed; the premolars and molars are in normal occlusion; the maxillary incisors are spaced; the mandibular incisors do not impinge on the muco-periosteum of the palate, but the arch formed by the teeth is often a little flattened. The projection of the maxillary incisors is usually traceable to an upward and outward pressure on the labial aspects of the teeth, such as would occur in the habit of sucking the lower lip or the prolonged use of a teething pad.

Group 2.—There are no indications of deficient growth of the jaws; the dental arches are contracted and the maxillary premolars and molars are usually in abnormal occlusion. The morbid anatomy of this type of superior protrusion is shown in fig. 360.

The maxilla and the mandible are well developed. In the maxilla the canines and incisors project; the premolars and molars have an abnormal forward slope and occlude anterior to their normal position. In the mandible the premolars and molars are in normal position, but the canines and incisors show the flattening which is characteristic of many cases of superior protrusion. The illustration

in the profile shows that the chin is well formed and that the part of the bone which is at fault is the alveolar process. The protrusion was due to a forward movement of the maxillary teeth, which was sufficient to allow the lower lip to lie posterior to them, and exert a backward pressure on the mandibular incisors and canines.

In this type of superior protrusion the narrowing of the arch is more marked in the premolar than in the molar region as shown by the following figures of hand-fed children:—

	A		B
Normal (without adenoids) (9 cases)	34·1	...	25·61
Protrusion (without adenoids) (18 cases)	33·9	...	24·5

Another important feature is the frequency with which an abnormal forward occlusion occurs in this type of superior protrusion.

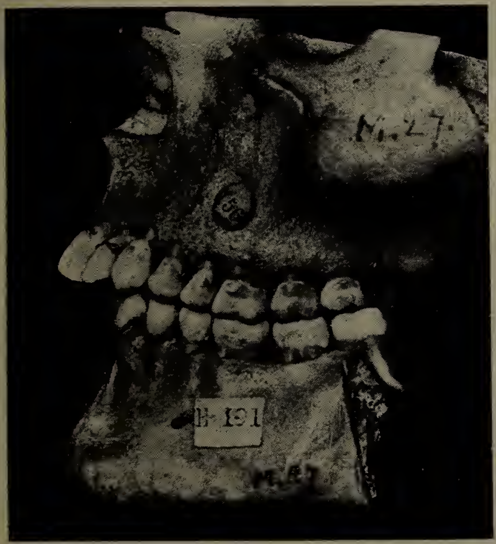


FIG. 360.

The abnormal forward occlusion implies either that the maxilla is normal and the mandible is imperfectly developed or that the whole of the maxillary teeth have moved forward. In the specimen, fig. 360, the body of the mandible is well developed and protrusion is due to a forward movement of the maxillary arch. This forward movement is attributable to the habit of thumb-sucking or to the prolonged use of a dummy teat "comforter"; the persistent sucking action brings pressure to bear on the sides of the arch and

the anterior segment carrying the canines and incisors is forced forward. At the same time a backward pressure is exerted on the lower teeth, and, as a result, the arch is flattened, the incisors often assuming a fan-shaped arrangement (see p. 242).

The models (figs. 361 to 363) are from cases due to persistent thumb-sucking.

Fig. 361.—A case of superior protrusion due to persistent thumb-sucking. Breast-fed. No adenoids.

Fig. 362.—Side view of case shown in fig. 361.

Group 3.—There is deficient growth of the maxilla due to the presence of adenoids, the projecting incisors presenting a crowded arrangement. The specimen, fig. 364, is an example of this type of superior protrusion. The first molars are in normal occlusion; the canines and premolars have an abnormal forward slope; the

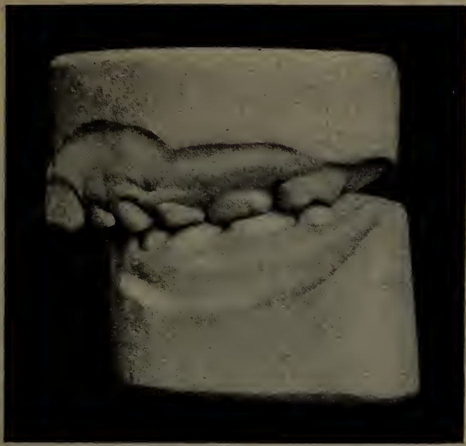


FIG. 363.—Breast-fed four months, then hand-fed with "boat-shaped" bottle. No adenoids. Thumb-sucker until 4 years of age. The arch of the incisors and canines is regular. The lower incisors do not impinge upon the upper gums.

maxillary incisors are crowded together, the apical portions of the roots being directed towards the median line, with the roots of the lateral incisors partially covered by those of the central incisors. The mandible is better developed than the maxilla. The incisors

FIG. 364.

and canines are crowded, and present a fan-shaped arrangement which is due to the pressure on the incisors exerted by the growing canines. The incisors are wedge-shaped teeth, the thin ends of the wedge being at the apices. If four wedge-shaped pieces of wood are placed side by side pressure on the thin ends of the wedges will force the centre wedges upwards, and this is exactly what happens with the lower incisors when the growing canines exert pressure on the roots of the laterals (fig. 365).

In discussing how the jaws and teeth are affected by the presence of adenoids it was shown that adenoids usually conduce to incomplete growth of the premaxilla which results in a crowded arrangement of the incisors; also to a narrowing of the arch and, in marked cases, the anterior part of the arch may be pushed forward, causing superior protrusion. It is doubtful, however,

Fig. 365.

whether the extreme protrusion seen in many of these cases is wholly to be attributed to the presence of adenoids and to the effects resulting therefrom. If a considerable number of children suffering from adenoids are examined it will be found that, while many of them have superior protrusion, a greater number will have a crowded condition of the teeth without superior protrusion. The frequency of abnormal occlusion in cases of superior protrusion would suggest that other causes are operating to produce this forward movement of the arch. In the majority of cases included in this group there is a history of the use of the "comforter" or of thumb-sucking, and these habits may be the determining factor in causing the protrusion. The models (figs. 366 and 367) are from a hand-fed child which suffered from adenoids until 8 years of age and had used a "comforter" for nine months.

Group 4.—The skull shown in fig. 371 illustrates the morbid anatomy of this group of cases.

The distance between the cutting edges of the upper incisors and the labial surfaces of the lower teeth is 4 mm., the cutting

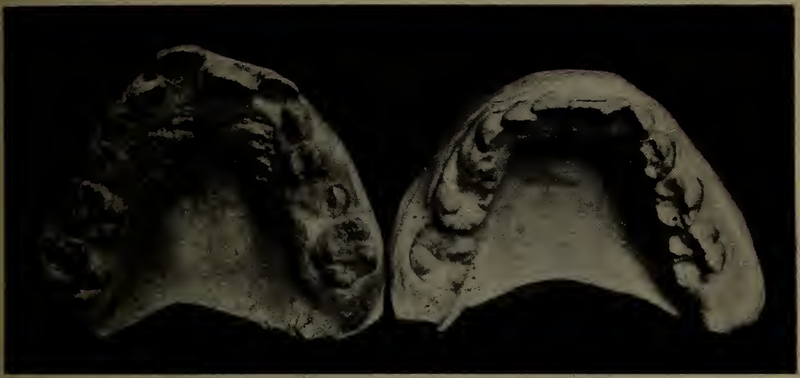


Fig. 366.—Hand-fed with a boat-bottle. Suffered from adenoids until 8 years of age. Comforter used for nine months. Occlusion 0·0. Upper incisors show a crowded condition. Lower incisors impinge on upper gums.

edges of the lower teeth being quite free from the palatal aspects of the upper teeth. The occlusion of the first molars is normal.

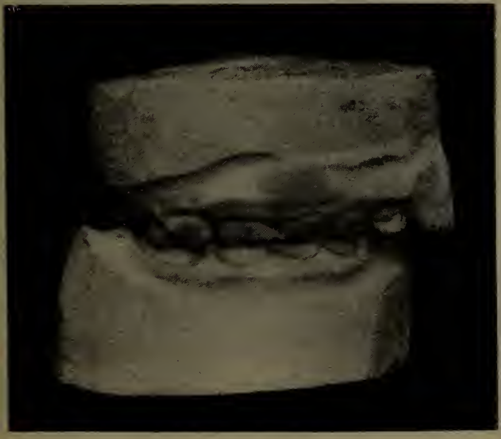


Fig. 367.—Side view of case shown in fig. 366.

The palatal aspect of the upper arch is shown in fig. 370, and it will be observed that (1) the incisors and canines slope unduly forwards; (2) the occluding surface of the first permanent molar

looks slightly backwards; (3) behind the erupting second molars there is no development of a tuberosity; (4) there is a distinct narrowing of the arch in all directions, more especially in the region between the canines and first premolars. The widths are as follows: between the (*a*) first permanent molars 34 mm.; (*b*) first premolars 25 mm.; (*c*) canines 20 mm.[1]

Fig. 368.

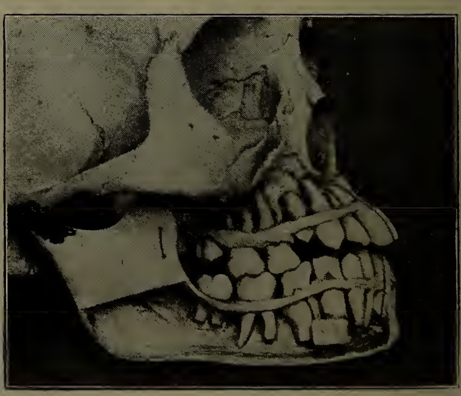


Fig. 369.

The arch of the lower teeth is regular, and the anterior teeth are somewhat more vertical than in the normal.

Side views of the skull are illustrated in figs. 368 and 369 and

[1] The measurements between the premolars and canines are approximate, as the teeth have not fully erupted.

show the abnormal slant of the upper incisors. Examined more in detail, it will be noticed that the roots of the incisors converge towards the middle line. The occlusion of the first molars is normal and they are placed directly under the malar process.

Fig. 370.

The outer alveolar process had been removed when the skull passed into the collection, and it is therefore impossible to define the extent of the antrum, but it would appear from an examination

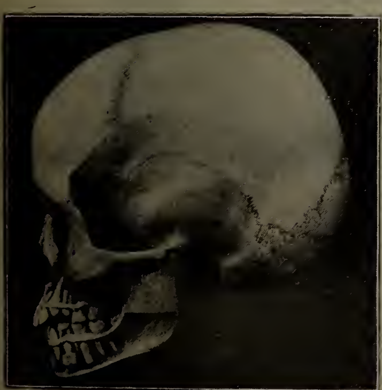


Fig. 371.—Skull of a child about 10 years of age showing superior protrusion.

Fig. 372.—Normal skull of a child about 10 years of age for comparison with the skull shown in fig. 371.

of the specimen that the antrum was very small and did not extend quite to the region of the second premolars.

Compared with the skull of a child about the same age, fig. 372,

this specimen shows a definite lack of growth of the frontal sinuses and the bones of the face.

The comparative measurements of the skulls point to a lack of growth of the maxilla.

The effect of this lack of growth would be to narrow the space available for the teeth and cause a crowding together of the roots and a forward movement of the crowns. In other words, if the roots of the teeth could be brought forward and spaced by a growth of bone the crowns would occupy a broader circle and the teeth would be more upright.

Group 5.—The arches are well formed and of normal width; the premolars and molars have not erupted to their normal height;

Fig. 373.

the mandibular incisors are above the level of the premolars and molars and impinge on the cingula of the upper teeth. The pathology of this condition is obscure. The condition seems to be due to diminished growth of the ramus. If the ramus is not fully developed the premolars and molars fail to erupt fully, and the result is that the lower incisors being on a higher level exert undue pressure in a forward direction on the backs of the upper incisors.

Group 6.—The greater part of the maxillary teeth occlude external to the mandibular teeth (see fig. 373). The irregularity is due to defective growth of the mandible.

In cases of superior protrusion the deformity increases as the

child approaches the age of 12 years. This is due to the pressure from the erupting canines.

(2) *Treatment.*

For the purpose of describing the treatment it will be convenient to divide cases of superior protrusion into two groups, namely, those in which the lower incisors do not impinge upon the cingula of the upper incisors or upon the gum posterior to those teeth, and those in which they do impinge on one or the other.

(i) Cases in which the Lower Incisors do not impinge on the Cingula of the Upper Incisors.—In discussing protrusion of the upper teeth, attention has already been drawn to the following facts:—

(*a*) The condition is often accompanied by a certain degree of abnormal growth of the bone, which disturbs the normal relation between the jaws and the teeth.

(*b*) The maxillary, and not the mandibular, arch is at fault in the majority of cases.

(*c*) The protrusion increases rapidly with the eruption of the canines.

These facts suggest that extraction of teeth to relieve the crowding, and extraction at an early age, is the best treatment. Treatment by early extraction certainly gives the most permanent and satisfactory results. Nevertheless it is not universally supported, and many practitioners deprecate any attempt at correction until the second permanent molars and the canines have erupted. It is not easy to discover any advantage that will accrue by postponing treatment, while the disadvantages of delay are obvious, namely:—

(1) The canine in erupting will move forward and accentuate both the protrusion of the incisors and the crowding of their roots.

(2) When treatment is commenced, the canine must be retracted by mechanical means, and in this process, instead of moving bodily back and so giving true relief to the pressure in the front of the mouth, the crown only will swing backwards, leaving the upper end of the root in much the same position as it erupted. The roots of the anterior teeth will thus remain more or less crowded and there will consequently be a constant tendency for the crowns to relapse into their former position.

(3) The retraction of the incisors will take a longer time, partly because the protrusion will have become more pronounced, and partly because the alveolar process will be more resistant.

(4) Owing to the prolonged mechanical treatment, disorganization of molar and premolar occlusion is more likely to ensue.

With treatment carried out before the eruption of the canines,

these teeth will erupt well back, pressure will immediately be taken off the incisors, the protrusion will not increase, and the mechanical treatment necessary will be slight. Still further, the teeth will come into good alignment, and the tendency to relapse will be reduced to a minimum. If early treatment is adopted, the room for the canines should be obtained by removing the unerupted first premolars as soon as the canines show signs of erupting. The method of carrying out this operation has been referred to on p. 211.

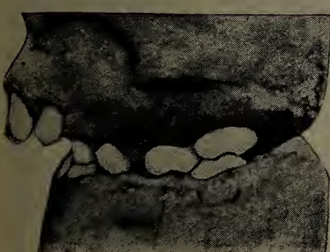
Fig. 374.—Before treatment.

Fig. 375.—Before treatment.

Fig. 376.—Stage at which mechanical retraction of the teeth was commenced.

After the removal of the premolars, the case should be left alone until the canines have fully erupted, the patient being strongly advised to keep the lower lip in front of the upper teeth. Occasionally, this simple expedient is sufficient to bring about a complete cure of the case. The effect of removing the pressure of the canines on the incisors is interesting. The laterals soon show a tendency to travel backwards, and this movement indicates a complete relief of the crowding of the anterior teeth. The incisors are eventually brought in with a simple mechanical contrivance, the teeth being retained in position until after the second permanent molars have erupted.

FIG. 377. FIG. 378.
Case shown in figs. 374 and 375. After treatment.



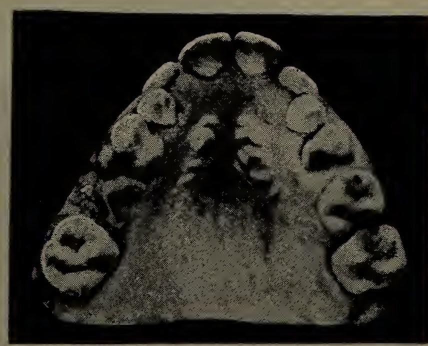


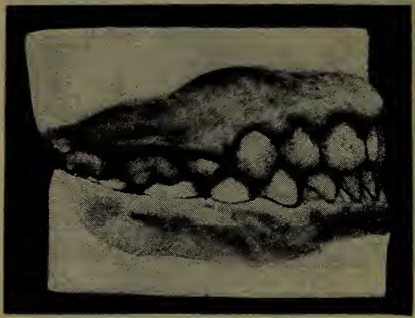
FIG. 379. FIG. 380.
Before treatment.

FIG. 381.
Stage at which mechanical retraction of the teeth was commenced.

With regard to the lower teeth, the treatment must depend on the condition existing. If they are crowded, the first premolars must be removed, but their removal should be delayed until the canines have commenced to erupt. Little advantage is gained by removing the mandibular premolars at an early age and in this respect the treatment differs from that recommended in the case of the maxilla.

When superior protrusion is treated at an early age excellent results are obtained; there is no tendency to recur; the amount of mechanical treatment necessary is trifling, and the occlusion of the premolars and molars is good. The cases shown in figs. 374 to 383 are examples of this mode of treatment.

In cases of superior protrusion which are not seen until after the canines have erupted, a prolonged spell of mechanical treatment



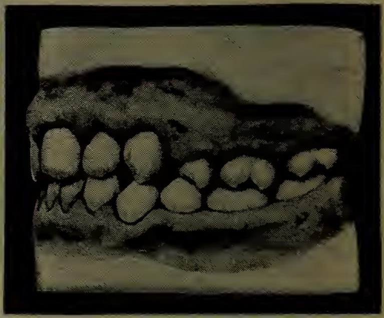


Fig. 382. Fig. 383.
Case shown in figs. 379 to 381. After treatment.

is usually necessary, and the results obtained are often far from satisfactory. The models shown in fig. 384 illustrate a variety often met with. The upper teeth are in a fairly regular arch, but the premolars and molars are abnormally placed in relation to the lower teeth. The fault is entirely with the maxilla, the mandible being normally developed. Provided that the first permanent molars are savable, the treatment would be the extraction of the first upper premolars, followed by the retraction of the canines and, subsequently, the incisors.

If the first molars are unsavable they must be removed. The extraction of the upper teeth may be undertaken as soon as the second permanent molars are sufficiently through to allow of their retention in position by means of a splint plate (fig. 286). This plate, as before mentioned, will prevent the second molars from

moving forward, and will allow them to erupt fully. It will also permit the premolars to travel back, provided that the bite of the lower incisors on the plate is so arranged that the premolars, upper and lower, are separated from one another during occlusion. No attempt should be made to move back the premolars by mechanical means until the second permanent molars are firmly

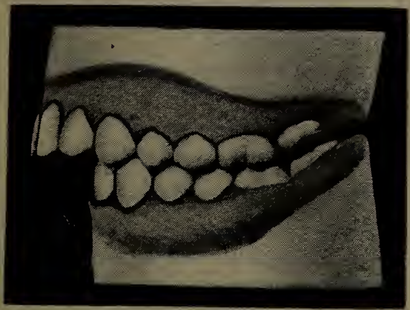


Fig. 384.

implanted, as the molars are liable to move forward if mechanical force is used too soon.

For retracting the premolars, a plate similar to that shown in fig. 385 may be used. It is important that the plate should occlude

Fig. 385.

correctly with the lower teeth in order that its rigidity may be augmented. It is advisable to retract only one premolar on each side at a time. If both premolars are retracted simultaneously, the second molar is very likely to move forward, as the resistance offered by two premolars is frequently greater than that of one molar, especially if the latter is not fully erupted. The premolars

should be moved far enough back to allow the anterior planes of the upper teeth to strike the posterior planes of the lower teeth, otherwise the posterior planes of the upper teeth will tend to drive the lower teeth backwards and so cause the abnormal articulation to persist (see figs. 386 to 388). If possible, the lower first molars should be retained until the premolars in the upper have been brought into correct occlusion. When the premolars are sufficiently retracted, the canines and then the incisors may be treated.

The results obtained are not very satisfactory, there usually being a tendency to relapse, due in a measure to the fact that

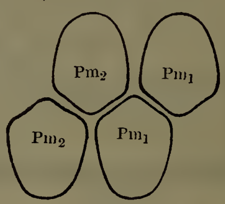


Fig. 386.—Diagram of articulation of superior protrusion cases which often require retraction of the upper premolars.

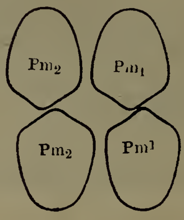


Fig. 387.—Diagram to illustrate the least extent to which upper teeth must be retracted. The posterior plane of the lower teeth will tend to drive the upper teeth backwards.

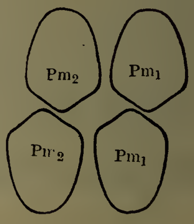


Fig. 388.—Diagram to illustrate insufficient retraction of upper teeth. The posterior planes of the upper teeth will tend to drive the lower teeth backwards and the abnormal articulation of the premolars will persist.

extraction of the molars gives but little relief to the crowding of the anterior teeth.

With excessive protrusion and unsavable first molars, it may be necessary to remove the first premolars, in addition to the first molars. The molars must be removed because they are unsavable, but their removal will not materially aid in the treatment of the protrusion. If the protrusion is left alone, the teeth are almost certain to be lost at an early age from periodontal disease. If the protrusion is to be treated with any hope of obtaining a permanent result, the premolars must be removed, and, when the one alter-

native is weighed against the other, the advantage would seem to be in favour of the extraction of the premolars and the permanent retention of the front teeth.

The operation of "jumping the bite" is recommended by some practitioners as a method of dealing with the variety of protrusion under consideration. In the case fig. 384 the lower premolars and molars are nearly the width of a premolar behind their correct articulation. If the patient can be made to acquire the permanent habit of bringing the mandible forward so as to make the teeth articulate normally, the bite will have been "jumped." The subject is one which has been voluminously written upon, and on which there is much diversity of opinion.

The means usually employed is to adapt to the upper jaw a plate at the anterior part of which is an inclined plane shaped to bring the mandible forward in the act of closing the mouth.

It is clear from the cases recorded that patients can be made to acquire, at least temporarily, the habit of protruding the jaw, and thus "jumping the bite." Does this habit become permanent, and, if so, what structural changes take place in the parts involved? By some[1] it is maintained that the changes take place in the glenoid cavity (1) by an extension of the condyle of the mandible, which practically amounts to a bending backwards of the neck; (2) by the filling up of the cavity posterior to the condyle. These explanations do not seem compatible with our knowledge of the anatomy and physiology of the temporo-mandibular articulation. A more likely explanation is that the teeth move forward in the sockets. When the teeth are occluded in the new position, namely, with the bite jumped, the muscles must constantly tend to retract the mandible to its old position; this backward tendency is arrested by the upper teeth, with the result that the lower teeth are drawn forward in their sockets and absorption and re-deposition of bone in the tooth sockets take place as when a tooth is moved by mechanical means.

E. H. Angle,[2] in referring to this point, states that cases examined four years after the termination of treatment show the backward tilt of the upper teeth and the forward tilt of the lower ones.

Some practitioners treat cases similar to that shown in fig. 384 by means of intermaxillary traction. Expansion arches are adjusted to both jaws, and the teeth are spread to the desired position; the

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[1] *Trans. World's Columbian Dental Congress,* vol. ii, p. 760.

[2] "The Treatment of Mal-occlusion of the Teeth." Seventh Edition.

expansion arches are then connected by elastic bands, as shown in fig. 389. It is claimed that by these means the lower teeth can be easily moved forwards and the upper backwards. When the

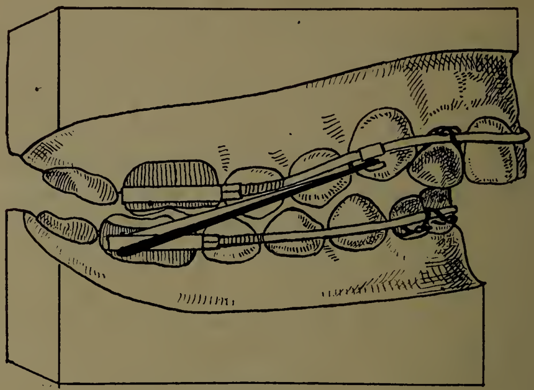

Fig. 389.

teeth are in normal occlusion, a retention apparatus is applied. The models[1] of a case treated in this way are shown in figs. 390 and 391.

Fig. 390.[1]
Left side.
Before treatment. After treatment.

A careful examination of the models shows that although the premolars were brought into correct occlusion the second molars have been rendered almost functionless.

[1] From "Operative Dentistry," by C. N. Johnson.

Where the protrusion is complicated by tilting of the laterals it is difficult to obtain permanent results. The crowns of the incisors are arranged in a fair arch, but in such a way that the roots of the laterals lie towards the median line. This condition is probably the result of adenoids, or some other form of nasal obstruction. The anterior nares, being functionless, do not develop properly, and so indirectly, and perhaps directly, affect the growth of the premaxillæ. In these cases the canines come down in such a way that their roots lie towards the median line. When retraction is applied to the tooth, although the crown is drawn backwards, the pressure on

Fig. 391.[1]

Right side.

Before treatment. After treatment.

the root of the lateral is not relieved, and may be increased. The space gained in the arch by the retraction of the canines admits of the incisors being retracted to a certain extent, but the effect of the retraction is to crowd the roots still more, and there is consequently a tendency to relapse unless a retention plate is regularly worn at night. The choice lies between (1) leaving the case alone, with the inevitable result that the condition becomes worse and periodontal disease supervenes; and (2) treating the case, and, after the teeth are retracted, impressing on the patient the necessity of wearing a retention plate at night.

[1] From "Operative Dentistry," by C. N. Johnson.

In the case shown in figs. 392 and 393 the lateral incisors have been forced slightly behind the central incisors. The first premolars were removed and the anterior teeth retracted. At the age of twenty-five (fig. 393) there was still a tendency for the teeth to relapse to their former position unless the retention apparatus was worn at night.

Where there has been considerable interference with the growth of the premaxillæ so that the root of the lateral incisor is covered by that of the canine, by far the most satisfactory results are obtained by the extraction of the laterals.. A typical case is shown in fig. 394.

(ii) Where the Lower Incisors Impinge on the Cingula of the Upper Incisors, or on the Gum Posterior to these Teeth.—These

Fig. 392.[1]
Before treatment.

Fig. 393.
Case shown in fig. 392 after treatment.

cases are difficult to treat and the results obtained are frequently unsatisfactory. If the mouth of a patient presenting this form of superior protrusion be examined, it will be noticed that the lower incisors are on a higher level than the premolars and molars. This may be due to some abnormal condition of the incisors, the height of the premolars and molars being normal; or the incisors may be normal in their arrangement and the premolars and molars unduly short; or again, both incisors, premolars and molars may be at fault. In order *that treatment may be successful, it is essential that the lower incisors should not impinge on the cingula of the upper incisors when the latter have been retracted.* It is therefore

[1] The patient was hand-fed and suffered from adenoids which had not been treated.

needful that attention should be directed to the treatment of the lower teeth. It has already been pointed out that the abnormal uprising of the lower incisors is due to crowding from lateral pressure of the canines, and that the shortness of the range of the molars and premolars probably arises from a defect in the development of the bones. As a first step in treatment, most practitioners endeavour to raise the bite—in other words, induce the molars and premolars to elongate and so prevent the lower incisors from impinging upon the cingula of the upper teeth. There are two strong *objections to treatment by raising the bite:* (1) the obstinacy, at times, on the part of the molars and premolars to rise; and (2) their liability to relapse by being forced down again into their

Fig. 394.[1]

sockets. It is not surprising that disappointment attends the practice of "bite raising," since the treatment is not in accord with our anatomical knowledge of the condition. *Failure to raise the bite* seems more likely to occur in cases where the molar and premolar region is well developed. There is a common impression that if teeth are separated from one another they will always elongate. That this view is erroneous will readily be seen by a study of that type of irregularity called "open bite." When the ascending ramus is short, the premolars and molars are probably prevented from rising to their normal height. If, therefore, the jaws are separated, the teeth will no doubt rise. It is in these cases that the liability to relapse occurs. Raising the bite does

[1] The patient was hand-fed, a tube bottle being used; she had also suffered from adenoids. The adenoids were probably responsible for the interference with the growth of the premaxillæ, and the marked narrowing of the arch was probably due to the use of the tube bottle.

not in any way affect the ramus, which is probably the real cause of trouble. The mouth is in reality propped open artificially and the muscles which close the mandible are in a state of tension. As soon as the plate is removed, the muscles have again free play and the pressure they exert drives the premolars and molars back to their original positions.

In a few cases, with the eruption of the second molars, the bite becomes raised by natural means, probably from a rapid growth of the ramus about this period. It is possible that in cases in which raising the bite by artificial means has been permanent the same natural causes have been at work.

More reliable results can be obtained by directing treatment to the mandibular incisors. Where the incisors and canines are not very crowded, their cutting edges should be ground down until they are clear of the upper teeth; at the same time it is most important that all lateral pressure should be relieved by the removal of a premolar or molar. If this is not done, there is a risk that when the third molars erupt they will exert a forward pressure and cause crowding of the front teeth. Where the incisors are very crowded, with the canines lying slightly anterior to the laterals, or where the fan-shaped arrangement is well marked, it is an excellent plan to remove an incisor. The crowding of the remaining teeth is efficiently relieved and the incisors usually fall to their normal level and are so prevented from impinging upon the upper gums or teeth. Removal of an incisor slightly narrows the lower arch, and this is, in my opinion, a distinct gain as far as treatment is concerned. Some, however, maintain that the narrowing of the arch may be detrimental to the facial expression because it will allow the lower lip to fall in. This view is incorrect. The prominence of the chin is governed by the mental process and is in no way dependent upon the alveolar portion of the jaw, which is alone involved in the removal of an incisor. When the upper teeth have been retracted the lower lip should close outside them and should not be dependent upon the arch of the lower incisors for its position. A case treated in this manner is shown in figs. 396 to 399.

The amount of protrusion is shown in fig. 396.

An examination of the models shows that as regards occlusion with the lower teeth the right upper premolars are erupting normally; on the left the upper premolars are not quite half a tooth in advance of their correct positions, the anterior planes of the upper teeth just striking the posterior planes of the lower teeth. The lower incisors are crowded and show the typical heaped-up appearance already alluded to (fig. 398). The cutting edges of these lower incisors strike the gum just posterior to the upper

incisors (fig. 400). The direction of the roots of the lower incisor teeth indicated that the left central should be removed. This tooth having been extracted, the case was left for a year, as the first permanent molars, which were unsavable, had to be removed, and this could not be done when the

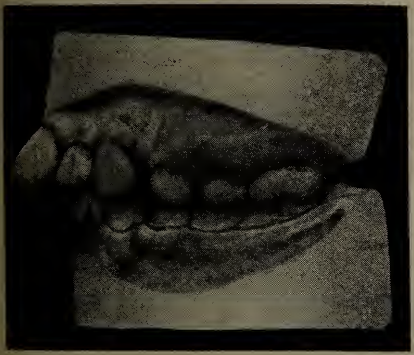

Fig. 396.—Left side before treatment.

Fig. 397.—Left side after treatment.

Fig. 398.
Lower incisors before treatment.

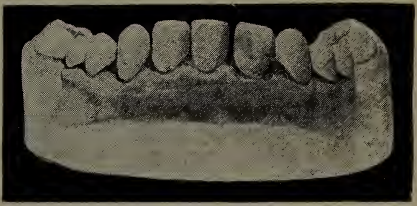

Fig. 399.
Lower incisors after treatment.

Fig. 400.—Showing relation of the lower incisors to the upper teeth at the commencement of treatment.

Fig. 401.—Showing relation of lower to upper incisors after treatment.

patient was first seen, as the upper second molars had not then erupted. When examined one year afterwards, the gap caused by the removal of the lower central had closed up, the teeth had apparently dropped down to a

lower level (see fig. 399), and were quite free from the upper gum. By the removal, therefore, of this central incisor one of the great difficulties in treating this type of case had been overcome. The first permanent molars were now extracted and a splint plate put in to keep the second permanent molars from moving forward and at the same time allow the premolars to travel back. The canines were then retracted and the incisors brought in. The result is seen in figs. 397 and 401. The lower incisors are quite clear of the upper teeth and the lower lip also passes in front of them. The upper teeth could have been retracted still more, but it was not considered advisable from an æsthetic point of view. This case has shown no tendency to relapse.

Much has been written respecting the tendency of cases of superior protrusion to relapse. There will be no tendency to relapse if we can—

(1) Ensure that the lower lip in occlusion passes in front of the upper incisors.

(2) Ensure that the lower incisors do not press unduly upon the backs of the upper incisors.

(3) Prevent crowding of the upper incisors and canines.

The tendency to relapse will be in proportion to the failure to overcome these difficulties.

(B) INFERIOR PROTRUSION—UNDERHUNG BITE

In this condition, when the mouth is closed, the upper front teeth pass within the arch of the lower teeth, instead of outside it; in other words, the mandible protrudes. This abnormal arrangement of the teeth may be limited to the incisors and canines, or it may involve the premolars and molars as well. Protrusion of the mandible is a natural condition in the edentulous.

Etiology and Pathology.—In the more simple examples of inferior protrusion the irregularity is due to a faulty occlusion of the teeth in jaws otherwise well developed; but in other cases it arises from faulty growth of the bones themselves.

In the *first group* may be included those examples which are traceable to *habits*, one of which is *the constant protrusion of the mandible* and another the *hooking of the fingers over the lower teeth* causing a forward movement of the incisors until they occlude anterior to the upper teeth.

In a definite variety of cases the irregularity is due to the *eruption of the upper permanent incisors internal to the existing deciduous teeth.* The permanent incisors, when fully erupted, pass behind the lower incisors and the latter assume a more forward position. The permanent maxillary canines in erupting move slightly towards the median line and so lock, as it were, the

incisors. Cases of this character are recognized by the general direction of the incisors, the upper teeth sloping backward and the lower teeth forward. The occlusion of the premolars and molars is usually normal. In fig. 402 is shown an example of this type of protrusion.

In the *second group* the etiology and pathology are frequently obscure. In many cases the trouble can be traced to a *defective growth of the maxilla* associated with adenoids. The lack of growth may be limited to the premaxillæ so that the only teeth involved in the deformity are the incisors, or the maxillæ may be generally affected. An examination of the mandible will not disclose any defect of growth.

Fig. 402.[1]

The most obscure cases are those in which the *defect is traceable to the mandible*. In some examples the mandible seems to be unduly large, the relation of the body of the bone to the ramus being normal. In others the protrusion appears to arise from a thrusting forward of the body of the bone due to an excessive growth of the ramus. In the skulls shown in fig. 403 this point is well shown. It will be noted that in the one marked (A) the mental process is unduly prominent, a condition not infrequently seen in these cases. An examination of the skulls will also show that the condyle of the mandible articulates correctly in the glenoid cavity.

This variety of inferior protrusion is occasionally transmitted through generations, a classical example being seen in the Hapsburg royal line.

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[1] From "Text-book of Operative Dentistry" (Kirk).

Fig. 404 shows the models of a case of inferior protrusion due to defective growth of the mandible. The lower teeth in occlusion are in advance of the normal. In fig. 405 are the models of a boy aged five years, showing well-marked protrusion of the mandible.

(A)

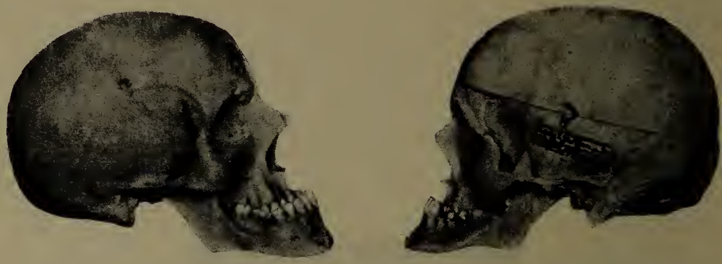

Fig. 403.

In some cases of forward bite, however, the articulation of the condyle is not normal, and in fig. 406 the condyle rests on the eminentia articularis. M. Cryer,[1] who drew attention to this

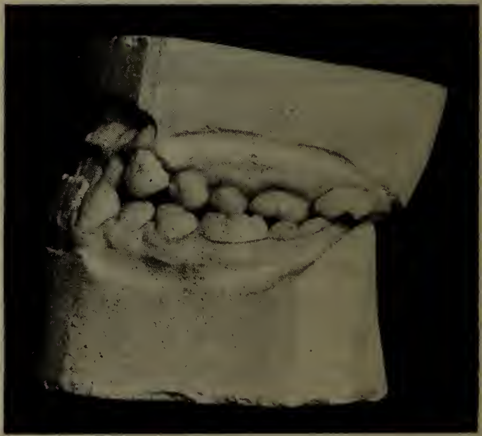

Fig. 404.

peculiarity, inclines to the view that the abnormal position of the condyle in these cases may be due to the use of forceps at birth; the mandible, he thinks, may be drawn forward, and, if the displacement is not reduced, the temporo-mandibular articulation will

[1] *Dental Cosmos*, November, 1906.

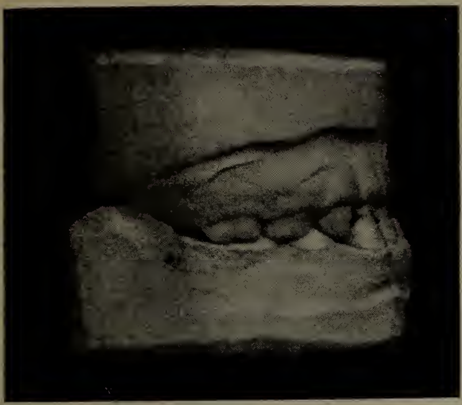

Fig. 405.

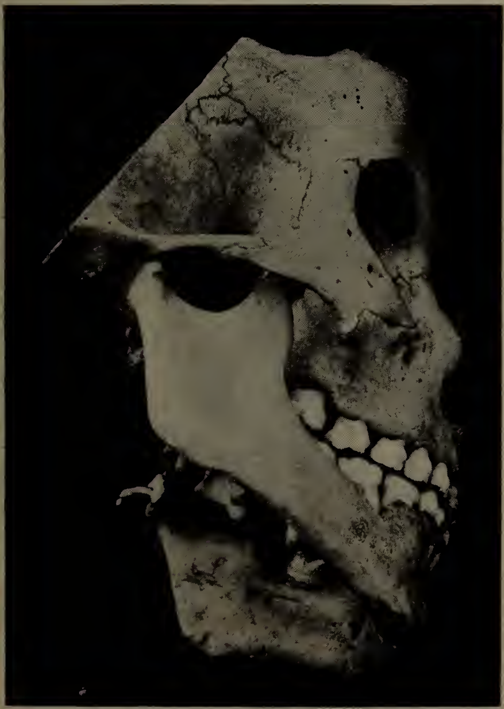

Fig. 406.

be changed from the glenoid fossa to whatever position the condyles may assume.

L. S. Chilcott[1] thinks that similar injury may follow difficult "breech presentation" cases. Cryer also quotes a case of forward bite associated with mal-position of the condyles in a man aged 35, who had been a case of breech presentation.

In acromegaly the mandible is frequently found enlarged.

In examining patients showing inferior protrusion, it will often be noticed that when the jaws are in repose the upper and lower incisors are in contact, leaving a space between the opposing premolars and molars, but during mastication the mandible is brought forward to obtain the necessary occlusion of the posterior teeth. This point should be remembered when cases are being examined with the object of ascertaining how far back the mandible can be taken.

Treatment

Where the irregularity is limited to the dental arches the mandibular incisors may be brought into correct position by mechanical means. A plate capping the mandibular premolars and molars, with a half-round gold wire impinging on the labial surfaces of the protruding teeth, will usually suffice.

If the protrusion is due to habitual thrusting forward of the mandible, the child must be broken of the habit and a skull and chin cap, similar to that shown in fig. 407, must be worn day and night. Cases of this type are curable.

In cases due to faulty growth of the jaw, the treatment adopted must depend in a very great measure upon the cause and extent of the deformity.

Where the fault is traceable to the maxillæ and the irregularity is slight, an expansion of the upper arch will often result in considerable improvement and at times in complete correction of the irregularity. Where the irregularity is more marked it is desirable that, in addition to expanding the upper arch, an endeavour should be made to reduce the arch of the lower teeth by the extraction of an incisor or the first premolars. By this treatment it is often possible to make the arch of the maxillary teeth pass beyond that of the mandibular teeth, and although some slight improvement in the expression may be gained, too frequently the treatment causes a complete disorganization of the articulation between the teeth. Further, the superior teeth, even though they may be in a plane

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[1] *Dental Cosmos*, March, 1906.

anterior to the inferior, do not overlap, the result being that a retention plate must be worn for a prolonged period to keep them in position.

Fig. 407.[1]

The case, the models of which are shown in fig. 408, will help to illustrate one or two points in treatment. The patient was a girl, aged 14. It will be seen that in complete occlusion there is a good deal of protrusion. In the mandible the first molars have been removed and in the maxilla the left upper first premolar has been removed to make room for the canine which erupted external

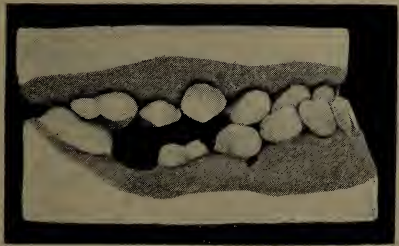

Fig. 408.

to the arch. The superior and inferior premolars fail to occlude, the result being that the whole process of mastication has to be carried on by the molar teeth. On examining the patient, it was

[1] From "Mal-occlusion of the Teeth," by E. H. Angle.

at once noticed that the mouth was kept slightly open, the lower incisors being brought into contact with the upper. The patient stated that this was the most comfortable position, and that, during mastication, she constantly suffered from discomfort in the region of the articulation. An examination of the articulation with the teeth in occlusion, as shown in fig. 408, demonstrated that the condyle was brought forward, and was not resting in its normal position in the glenoid cavity. The protrusion was thus to a great extent artificial, and a fair result could be anticipated with proper treatment.

The lines on which treatment in such a case should be carried

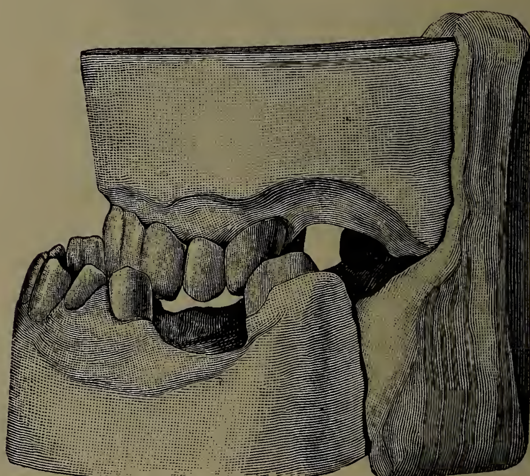

Fig. 409.

out are as follows: The anterior superior teeth should be brought forward and a biting apparatus inserted in the lower.

In cases such as that shown in fig. 409 the deformity is greatly exaggerated by the loss of the posterior teeth. The insertion of artificial dentures will not only assist in restoring the masticating area, but, if the bite is raised, will hide the deformity to some extent.

When the protrusion of the mandible is so marked that the upper teeth bite completely within the arch of the lower, steps should be taken to procure a masticating area. This may be effected by the insertion of dentures, the exact plan to be followed in each case depending upon circumstances. In severe types of inferior protrusion, similar to those just referred to, it might be

possible to improve the condition by surgical means. Several cases have been reported where surgical treatment has been adopted.

In considering the advisability of adopting resection of the mandible, the pros and cons must be carefully weighed. Resection of the mandible is always an operation attended by considerable risk, and even if the resected parts unite, the occlusion of the teeth is very likely to be so defective as to necessitate the use of dentures. It would therefore seem that by resection we cannot rely on gaining more than an improvement in appearance. Whether it is justifiable to submit the patient to the risks of a severe operation in the hope of gaining some improvement in personal appearance is a doubtful question.

When it is necessary to obtain a masticating surface, the better plan would certainly seem to be to disregard the question of appearance and treat the case by the insertion of dentures. In one case under my care (a young girl) the question of resection was carefully considered, and the method suggested was the resection of the mandible in the median line in preference to resection on either side. Treatment on these lines would be attended with less risk than bilateral section.

Cross Bite.—Cases in which there is unilateral protrusion of the lower teeth, a condition familiarly known as "cross bite," may conveniently be included in this section. This irregularity may be traced to habit, or may arise from a defective growth of the maxillæ, the "cross bite" being acquired by the child in its efforts to obtain an occlusion of the premolars and molars.

When the irregularity is due to habit, an apparatus may be contrived to counteract the habit and so restore the normal occlusion. Where, however, the "cross bite" arises from want of proper growth of the maxilla, an improvement may be obtained by an expansion of the upper arch.

(C) LACK OF OCCLUSION—"OPEN BITE"

This term is applied to that abnormality in which the back teeth alone occlude when the mouth is closed.

From a clinical point of view "open bite" may be considered under three groups:—

(1) Where the premolars and the molars occlude, but the cutting edges of the upper and lower anterior teeth are separated from one another by a space more or less oval in shape.

(2) Where the majority of the posterior teeth, as well as the anterior teeth, fail to occlude.

(3) Partial lack of occlusion in the premolar and molar regions.

Etiology and Pathology.—In group (1) the deformity is invariably the result of an acquired habit, such as thumb- or finger-sucking, the thumb or finger being bent and inserted horizontally between the cutting edges of the upper and lower teeth. The pressure thus exerted forces the upper teeth, as well as the alveolar process, in a direction upwards and slightly outwards. The lower teeth are forced downwards, but the displacement is far less marked than in the upper.

Cases included under group (2) vary greatly in the degree of their severity, so that while in some cases the irregularity may consist merely of a slight separation between the teeth, in others

Fig. 410.[1]

it may extend to the condition shown in fig. 413. This type of "open bite" is invariably accompanied by a marked narrowing in the region of the premolars and molars. In twenty-four measurements taken, the figures were 30·56 mm. between the first molars and 21·35 mm. between the first premolars. Compared with normal breast-fed children, the width across the molars and premolars is 100 : 88·4 and 100 : 80·7, respectively. The occlusion of the teeth is not so abnormal as in superior protrusion, only a small percentage showing the "too forward occlusion." Hypoplastic teeth are invariably present, the condition often being very marked, and there is almost always a history of long-standing adenoids. The maxilla is defectively developed, the arch in the region of the

[1] From a photograph by J. E. Grevers.

molars and premolars being often within that of the mandibular teeth. In one section of these cases the opening increases progressively from behind forward; in another section, there seems to be marked bending down of the lower arch in the region of the first mandibular molar; while in a third section the mal-occlusion is considerably accentuated in front by an upward curvature of the maxillary incisors; and a fourth section is found to combine the defects of sections 2 and 3. Unfortunately, morbid anatomy specimens of "open bite" are rare. Fig. 410 illustrates certain points noticeable in many of the cases, namely, an unusual growth of the anterior part of the mandible; a short sloping ramus, and a marked bending of the mandible at a point near the spot where the facial artery crosses the bone. The pathology of the condition is obscure. H. Schmidt, as quoted by H. Baldwin,[1] considers that when the mouth is kept open, as in marked nasal obstruction, the tongue is held down to the floor of the mouth and the tongue's tip is pressed against the front part of the lower jaw and teeth, exerting a downward and forward pressure. This pressure, operating on yielding bone, causes the alteration of the angle and so produces the deformity.

The constant presence of adenoids and the association of the condition with hypoplastic teeth, which must be regarded as a sign of previous rickets, suggest that "open bite" is due to the ill-effects of adenoids plus rickets. We know that the weight of the cheeks tends to narrow the jaw, and if this weight is acting on easily pliable bones the effect will be accentuated. This will account for the marked narrowing of the arch. In severe cases, the mandible takes a marked bend downwards, near the anterior border of the masseter, and this condition is probably due to a bending of the bones caused by the downward pull of the muscles which open the mandible, counteracted by the elevators of the mandible. The upward displacement of the maxillary incisors is probably due to the action of the comforter, or the teat of the bottle, on bones softened by rickets. In other words, the agencies which produce general crowding and protrusion, when combined with rickets, produce grosser lesions which show themselves in the form of "open bite."

The cause of *partial lack of occlusion* in the premolar and molar region is often obscure. In a few cases, faulty extraction seems responsible for the condition.

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[1] *Dental Record,* vol. ix, p. 147.

Treatment

It is impossible to lay down any hard-and-fast rules for the treatment of "open bite," as each case must of necessity be considered on its merits.

Class (1), namely, **where the deformity is limited to the anterior teeth.** When seen at an early age, before the eruption of the permanent teeth, much may be done by breaking the patients of any vicious habits they may have acquired, and, with the eruption of the permanent teeth, the condition will be improved to some extent. When the habit of thumb-sucking, &c., has been continued during the eruption of the second dentition, or when the deformity is severe, treatment is of little avail. But it should be remembered that, although the appearance of the patient may be a little unsightly, the premolars and molars articulate, and the posterior teeth can, therefore, adequately perform their function of mastication. In these circumstances, it is generally better not to interfere, although, where the personal appearance is of the first importance, the crowning of the upper six anterior teeth might be deemed advisable. In a very severe case crowning would hardly be practicable, and it would be preferable to remove the anterior teeth and insert a denture.

Class (2), namely, **where the majority of the posterior teeth fail to occlude.** A considerable improvement may be made in many cases by cutting in the bite. This method is extremely satisfactory, and may be employed alone or in combination with either extraction or the skull and chin cap. The treatment consists in grinding down the teeth until the premolars and molars articulate. This operation might with advantage be more generally adopted. The points in its favour are : (1) It gives the patient a good surface for mastication; (2) it is permanent—teeth forced down by the skull and chin cap tend to rise again as soon as the apparatus is discarded; (3) it relieves the patient of a long and tedious course of treatment.

The operation should extend over several sittings, and a fair interval should be allowed to elapse between each. In the case shown in figs. 411 and 412, the treatment was spread over a period of one year. The object of leaving an interval between each sitting is that the pulp has time to react to injury caused by the operation, and the secondary dentine thus formed allows a greater portion of tooth structure to be eventually removed. The patients should be directed to apply spirits of wine to the cut surfaces twice a day, and the necessity of thoroughly drying the surfaces and keeping them free from saliva for about a minute after the spirit has been

applied should be impressed on them. By this means, the cut surfaces of the dentine are hardened to some extent and any sensitiveness that may exist is diminished. It is also a good plan, after each sitting, to apply nitrate of silver to the cut surfaces.

FIG. 411.

FIG. 412.

FIG. 413.

FIG. 414.

Another case treated by cutting in the bite is shown in figs. 413 and 414.

Where the deformity is only slight, an attempt may be made

to correct the condition by the use of the skull and chin cap. If this treatment is to succeed, the apparatus must be constantly worn and the elastic bands stretching between the chin and skull caps arranged so as to exert pressure in an upward and not a backward direction.

In most cases the removal of teeth will be necessary. The extraction of the second molars may suffice to remedy some examples, but unfortunately the first molars are generally unsavable and in these circumstances the removal of the second molars is hardly justifiable. Under such conditions, the following course of treatment will often yield satisfactory results. Remove the first molars and use a skull and chin cap for a period of from six months to one year. If the occlusion is then still open, the operation of "cutting in the bite" may be resorted to. Where the arch of the

Fig. 415.—Patient, aged 21. Breast and hand-fed fifteen months. Neave's food. Tube feeding-bottle used. Adenoids present, not treated. Teeth hypoplastic. History of rickets; no history of use of comforter or thumb-sucking.

maxillary teeth is contracted, the occlusion may often be improved by tilting the molars and premolars outwards.

In severe forms, such as that shown in figs. 415 and 416, extensive extraction must be resorted to, followed by the insertion of dentures.

In this case $\dfrac{765 \quad | \quad 34567}{87\ 54 \quad | \quad 567}$ were removed and dentures adapted with the result seen in figs. 417 and 418.

Some practitioners, in treating "open bite," adopt the plan of shortening the molar region and lengthening the incisors, canines and premolars; but such treatment cannot be relied on to give permanently good results. In connection with such treatment, it must be remembered that patients with "open bite" invariably

Fig. 416.

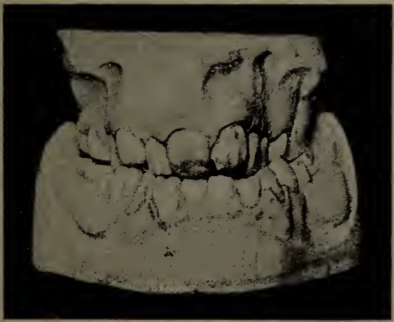

Fig. 417.

Fig. 418.

have gingivitis of long standing. The multiplicity of bands and ligatures required to carry out this treatment cannot fail to add considerably to the gum lesion, and it is more than probable that they will give rise to serious periodontal disease.

Cases of "partial open bite" must be dealt with by some form of mechanical appliance if it is considered expedient to treat them.

(D) ABNORMALITIES OF THE TEETH ASSOCIATED WITH CONGENITAL DEFECTS OF THE JAW

This class of irregularities forms a small but well-defined group.

(i) Associated with Arrest in Development of the Mandible.— A partial arrest in the development of the mandible may occur. The effect of the malformation on the dental arches will be to draw the teeth towards the affected side and at the same time cause the lower incisors to pass well behind the upper teeth, with the result that the lower lip will fail to cover the upper teeth and a marked protrusion of these teeth will follow. In treating such irregularities, little can be done beyond reducing the upper arch and retracting the incisors.

(ii) Hare Lip.—Where the suture in the incisor region is involved, considerable irregularity of the incisors frequently follows. Great caution should be exercised in attempting the correction of these irregularities. The roots of the incisors are often malformed, and, if treatment from an æsthetic point of view is necessary, the extraction of the teeth and the insertion of a denture is usually the wisest course to pursue.

(iii) Cleft Palate.—In cases of cleft palate complicated by hare lip, the incisors adjacent to the fissure are often misplaced, and may erupt into the nasal cavity. As a rule, it is inexpedient to attempt their regulation, the roots of such teeth being usually curved and twisted. If the condition produces great disfigurement, the teeth can be removed and a denture inserted.

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CHAPTER X

Bacteriology of the Mouth

By N. Mutch, M.A., M.D., M.R.C.P.

NATURE AND SIGNIFICANCE OF BACTERIA

Since bacteria were first seen by Leeuwenhoek in the seventeenth century many thousands of varieties have been differentiated and named. They are minute living entities more closely related to the vegetable than to the animal kingdom. The lengths of the large ones are commensurate with the diameter of a red corpuscle, whilst the smallest ones are of almost ultra-microscopic dimensions. Fortunately only a very small proportion of the earth's bacteria are harmful to man, and as far as possible attention will be confined to these *pathogenic* varieties. The body can sustain damage from their action in two different ways:—

(1) By the invasion of its tissues.

(2) By the harmful influence of noxious substances produced by the organisms from the decomposition of food, surface exudates and débris.

The former method of offence is peculiar to the true *parasites* or *infective* organisms. The latter is exercised by many classes of germs, both infective types and non-infective or *saprophytic* varieties.

INVASION OF THE TISSUES BY BACTERIA

Many bacteria can penetrate an intact mucous membrane without producing any disruption of the surface, although ingress is facilitated by previous damage. In every case survival of the invading organism is determined by its power of drawing upon the surrounding cells for sustenance. In whatever medium a micro-organism lives, a continual exchange takes place between the substances dissolved in its plasma and those of the surrounding fluids. Foods are taken in, effete metabolites are excreted and products such as ferments given out which prepare the food for absorption. Thus enzymes capable of digesting starch are often

diffused into the medium by bacteria able to utilize the resulting sugars. Bacteria adapted for survival in the tissues not only secrete ferments but also powerful poisons or *toxins* with the object of injuring the neighbouring cells, so that these may be digested into simple substances suitable for the organism's food.

Bacteria which enter, destroy and prey upon the tissues are said to have *infected* the tissues. They are harmful in that—

(1) Cells are destroyed, and the process may spread until some vital organ is rendered useless.

(2) The toxins may diffuse and, reaching the blood-stream, damage distant structures which are still separated from the infected focus by a mass of healthy tissues.

To oppose this invasion and destruction which has repeatedly assailed our ancestors through countless generations certain defensive mechanisms have been evolved. There is an outer guard and an inner guard. Opportunities for invasion are minimized by an impervious integument. A very efficient system of drainage and lavage of all mucous membranes minimizes the accumulation of bacteria on their surface. In certain places such as the stomach, where stagnation cannot be avoided, the mucosal secretions actually kill almost all bacteria with which they come in contact. In other localities cells migrate from the body into the exudates and act as scavengers, destroying and digesting any bacteria which they meet. Frequently, however, the outer guard is passed and the organism encounters the second line of defence. This consists of leucocytes and other migrating cells able to ingest the invaders, and of *antibacterial* substances able to poison the micro-organisms just as the toxin of the bacteria poisons the cells of the body. At the same time other substances, *antitoxins*, neutralize such harmful bacterial products as diffuse into the tissues.

Immunity reaction is a general term covering the whole protective complex. The local reaction at the site of invasion is known as *Inflammation*. This inner guard must be examined in greater detail.

Inflammation

The neighbouring arteries dilate and flush the area with blood. Then slowly the flow is retarded and the leucocytes separate from the red corpuscles, the former taking up positions in the outer zones of the stream. A great exudation of fluid passes from the blood-vessels to the lymph spaces and leucocytes migrate through the capillary walls by *diapedesis*, i.e., without any apparent discontinuity of the endothelial lining. In a short time the offending

bacteria are bathed in lymph charged with anti-bacterial and antitoxic substances and are surrounded by dense masses of leucocytes. The exact rôles of the different varieties of migratory cells is not known, but certain of them—the *phagocytes*—ingest the bacteria, and others have been observed to discharge granules as though with the object of poisoning the invaders or of supplying antidotes to their toxins or of preparing them for ingestion by the phagocytic varieties. The leucocytes not only accumulate locally, but their numbers in the general circulation rise and a *leucocytosis* is produced. Metchnikoff's name is particularly associated with the discovery of these leucocytic phenomena.

The Lymphatic Glands

Although bacterial toxins readily find their way from infected areas into the blood-stream, the bacteria themselves effect this passage with greater difficulty. The more usual route of migration is along the lymphatic vessels to the nearest group of lymphatic glands, where they are destroyed in large numbers.

Specific Immunity

Many complex organic substances, including bacterial toxins, on entering the body evoke a reaction whereby a specific antidote or *antitoxin* is produced. Similarly, when a foreign cell such as a bacterium is introduced a specific *lysin*, which in the case of the bacterium is called *bacteriolysin*, is evolved, capable of destroying the invading cell and that alone. The production of both these classes of protective substances takes place whenever the tissues are infected. It is a curious fact that if the dose of the toxin or the number of the bacteria is not too great, the antidotes are produced in excess of the quantities immediately required. This phenomenon forms the basis of much of modern bacteriological therapeutics. By inoculating horses with increasing doses of toxin, sera have been obtained with intense antitoxic properties. Such a serum is that used in the treatment of diphtheria. Similarly anti-bacterial sera have been made. In vaccine therapy known numbers of dead bacteria are injected into the patient, who then supplies anti-bacterial substances for himself capable of dealing with the living germs of the same race which are infecting him. Ehrlich was perhaps the most prominent elaborator of hypotheses in explanation of these phenomena.

From the foregoing paragraphs it is apparent that only *virulent* germs have much chance of establishing themselves in the

tissues, and that even they must wage constant warfare against the protective processes of the body.

THE MICRO-ORGANISMS OF THE MOUTH

These belong to three great classes:—

I. The everchanging stream which enters with the food and air and passes to the stomach to be destroyed.

II. Those which prey upon food particles and débris in stagnant pockets wherever the surface drainage is inefficient.

III. Those which infect the tissues.

The first group is of very great variety, but of no concern except as the source from which Groups II and III are recruited.

The second and third groups are not present under conditions of perfect health, and in disease vary according to the local environment provided for them. Let us imagine an artificial zone of food stasis produced experimentally near the gum in a hitherto healthy mouth. The bacteria in the arrested food particles, incubated in the moist warm atmosphere of the buccal cavity, will multiply in numbers and compete amongst themselves for the food. The weapons used in their competition are speed of growth and the generation of decomposition products harmful to rival races. After a short time the number of different strains will have been greatly diminished, and amongst the survivors a state of equilibrium established which will continue so long as the conditions remain unaltered. The nature and relative proportions of the organisms which persist will vary according to the character of the food supplied, whether meat or bread, with the opportunities for the diffusion of decomposition products and the neutralization of acids, and with the accessibility or the reverse of free oxygen supply. These are merely cited as obvious controlling factors. The actual variety in operation in different mouths is probably very great, but in each instance they are reflected in the bacterial equilibrium of the area. A thousand bacterial strains may enter the mouth in the course of a day, but the races present in a food pocket may not be more than a dozen.

The third group is the smallest of all, and includes only organisms of the infective type. The most virulent, on entering the mouth invade the mucosa at once and produce acute infections. After a varying interval of time they may be wholly destroyed by the defensive reaction which is evoked, or they may be destroyed only in part, and a few continue to live in small circumscribed areas where the vitality of the tissues is impaired by local factors,

notably in the regions around foci of food stasis. In this manner a chronic infection follows upon the acute one, and only comes to an end when the processes which give rise to the local zones of subnormal tissue resistance are eradicated. Other organisms of lower virulence accumulate and live as saprophytes in food pockets and, using these as bases, slowly gain a foothold in the tissues. In this manner also, a chronic infection is established which persists so long as the surface drainage is imperfect. Chronic infections are much more easily evolved when the resistance of the body as a whole to bacterial invasion is impaired. In almost all pronounced examples of these infections the constitutional factor is an important one, and demands as much consideration in the treatment as does the local mechanical condition in the mouth.

THE HARMFUL EFFECTS OF INFECTION OF THE MOUTH

(1) Infected Debris

Neighbouring tissues are damaged by the decomposition products and the way prepared for invasion by infective bacteria. Many cases of gingivitis and of more deeply seated infections of the gums and tooth sockets are probably initiated in this way. The constant diffusion of irritating substances produces similar sequelæ in other parts of the buccal cavity. Furred tongue, superficial glossitis, tonsillitis, chronic enlargement of the tonsils and chronic pharyngitis are often determined in this fashion.

After being swallowed they irritate the stomach and produce gastritis with abdominal pain, loss of appetite, nausea and vomiting. Many are absorbed and play a part in the chronic toxæmia of dental sepsis.

(2) Infected Tissues

Acute pulpitis is frequently the result of infection *via* a carious cavity in the tooth. Destruction of the gums, their retraction from the teeth, loosening of the teeth and wide-spreading inflammation of the surrounding tissues, such as alveolar abscess, empyema of the antrum, caries of the jaw and cellulitis extending to the orbit or even to the connective tissue planes of the neck are sequelæ of the bacterial invasion of the gums. In almost every instance there is some degree of enlargement of the cervical lymphatic glands. Most of these conditions are described in other parts of this book, but the enlargement of the lymphatic glands may be considered here. During the process of destroying bacteria which enter from an infected focus, the lymphatic glands enlarge

and become tender. They are then said to be in a state of *acute adenitis*. Sometimes, instead of overcoming the bacteria, the glands are themselves destroyed and their disintegrating cells form a collection of pus, walled in by a ring of defences similar to that already described as surrounding the original infected focus. This constitutes an abscess. In connection with buccal infections of a chronic nature, a third condition sometimes arises. Organisms reaching the glands in fluctuating numbers are sometimes killed at once, but at other times destroy a few gland cells before they succumb. These destroyed cells are replaced partly by others and partly by little masses of fibrous tissue. In the course of time the glands become permanently enlarged and consist of varying proportions of connective tissue and regenerated lymphatic tissue. Such glands are only tender during exacerbations of infection and are said to be in a state of *chronic adenitis*. They are an index of chronic infection in the area which they drain, and may also become a menace in themselves. Their powers of destroying bacteria being partly exhausted, the glands are no longer a sure defence against new invasion and frequently become the seat of tuberculous disease.

From the areas of infection around the teeth, bacteria are thrown off in millions and may infect the rest of the buccal cavity, occasioning glossitis, tonsillitis or pharyngitis, from which again extension may take place along the mucous membrane to the larynx, trachea, bronchi, and even the pleura and the terminal alveoli of the lungs. In chronic buccal infections these secondary lesions are usually mild and recurrent, but when the mouth infection is virulent, serious and even fatal diseases such as broncho-pneumonia and empyema may follow.

The bacteria which are swallowed and reach the gastro-intestinal tract merit special consideration. The majority are destroyed by the acid of the stomach, but a few always pass through, protected in small particles of food, although their passage is rendered easier by such factors as fatigue, unappetizing food and acute infections which diminish the gastric secretion. Those which gain the small intestine are hurried downwards in accordance with the general system of mucous membrane drainage until they reach the colon, where delay for many hours is inevitable. Here food is scarce, and competing for it are teeming masses of harmless saprophytes. The fate of most of the swallowed bacteria which escape destruction in the stomach is death by starvation in the colon unless they are virulent and gain speedy access to the tissues through such avenues as piles and stercoral ulcers. Very commonly

as the result of chronic intestinal stasis secondary loci of stagnation develop in the ileum, where a considerable amount of food is accessible in the chyme and conditions frequently arise favourable for the survival of certain strains of bacteria from the mouth, notably *Streptococcus longus*. Infective bacteria from such chyme invade the mucosa and spread, so that infections are established in the bowel secondary to those already involving the mouth. Thus the combination of buccal sepsis with intestinal stasis gives rise to a large variety of intestinal lesions, including many cases of such serious disorders as appendicitis and colitis.

Of swallowed organisms only those which come to rest in suitable surroundings survive in the bowel. Chronic infections of the mouth help to evolve races specially fitted for life in the intestines. Probably the most important instance is that of the infective organism *Streptococcus longus*. Imagine, as often happens, that the gum around a focus of food stagnation becomes infected with this coccus. The bacteria on the surface are repeatedly placed in contact with impacted carbohydrate. Laved in a sugary medium, successive generations slowly acquire the power of preying upon this substrate and a strain is developed which, although retaining its infectivity, can live freely and multiply rapidly amongst inert carbohydrate residues. At the same time its ability to form acid from the sugar is greatly increased, and by means of this weapon it can destroy a large number of rivals, including *B. coli communis*. Such an organism is specially adapted for the production of chronic infection wherever carbohydrate stagnates in the bowel. It can live as a saprophyte in the chyme, competing on favourable terms with the normal saprophytes of the region. Passing thence it can invade the tissues, and often survives in spite of the defensive mechanisms of the body. When once established, such an infection persists, even though the mouth is made clean, because it can continue indefinitely until conditions in the chyme and in the tissues become inimicable at one and the same time, and such a double event rarely arises spontaneously. Although elimination by the dental surgeon of the inflow of bacteria is essential, the treatment involves many other measures. Great good is effected by dietetics and drugs which ensure that the intestinal contents shall not be a suitable pabulum for the infecting organisms, and by vaccines and other means whereby the body is assisted in destroying such organisms as have already invaded the tissues. Neglect of these secondary zones of infection in the intestines is the cause of much disappointment in the treatment of diseases arising from dental sepsis.

From the original focus in the mouth and the whole area of secondary infection in the throat and intestines bacteria and toxins are absorbed and, with the decomposition products of the infected débris, produce a chronic toxæmia which shows itself in malnutrition, lack of energy, easily induced fatigue, loss of muscular tone, opacity of the skin, slight anæmia and aggravation of all the symptoms of disease in other organs, particularly in other parts of the digestive tract. The bacteria often reach the blood-stream and give rise to septicæmia of all grades from latent intermittent trivial types to rapidly fatal varieties. The former are particularly associated with chronic dental sepsis and the latter with acute infections. Poisons and bacteria are thus disseminated to all parts of the body. Several general conditions arising in this way, more especially in connection with chronic infection, will now be described in more detail.

Anæmia

Poverty of the blood is a common feature of almost all chronic infections. In chronic streptococcal disease of the digestive tract the hæmoglobin frequently falls to 80 per cent. of the normal. In a certain number of instances of the same condition it falls to a value as low as 30 per cent., and the anæmia is of the most profound type, equal in degree to that of serious and protracted hæmorrhage.

This grave variety is sometimes designated *Septic Anæmia*. Both the minor and major septic anæmias are due chiefly to defective blood formation, although in many cases there is evidence of some excessive blood destruction also.

Chronic Infective Arthritis

In the majority of patients with this variety of arthritis (gonococcal cases being excluded) chronic infective conditions are present in the mouth and intestines. The organism is usually *Streptococcus longus*, but in a small percentage of cases pyogenic staphylococci are present. The bacteria concerned can often be isolated from the mesenteric glands and the blood-stream, as well as from the mouth and intestinal contents. Chronic subsidiary foci are set up at the articulation which result in effusion of fluid into and around the joints, and eventually great thickening of the synovial membrane and ligaments with fibrous ankylosis, contractures and dislocations. The various infected areas, namely, the mouth, intestines and joints, show sympathetic variations. Thus the symptoms in all parts vary in a parallel manner after the injection of autogenous vaccine. Removal of the teeth often

excites diarrhœa and an exacerbation of arthritis because the traumatism affords opportunity for a greater invasion of the tissues. It is consequently desirable to treat the mouth by simple means at first, and only perform extractions at a later date when the condition has been controlled a little, the bowels have been considered, and specific immunity has been raised by vaccines.

Muscular Rheumatism

Muscular rheumatism is probably caused by capillary embolism with bacteria of low infectivity, and in chronic cases the source of the bacteria is usually mouth and intestines.

Infective Endocarditis

Infection of the lining membrane of the heart is called *Endocarditis*. Rapidly progressive varieties are described as *Infective Endocarditis*, and can be produced by many different races of bacteria. The infective variety does not usually commence in healthy valves, but only in such as have been previously affected by simple endocarditis. The secondary invaders are frequently supplied from foci of infection in and around the mouth.

Summary of the Harmful Effects of Mouth Infection

(1) Infected débris.
- (*a*) Damages the teeth, gums and general buccal mucosa, and prepares the way for infection of the tissues.
- (*b*) Is swallowed and irritates the stomach.
- (*c*) On absorption produces toxæmia.

(2) Infection of the tissues.
- (*a*) Produces local damage to the teeth and gums.
- (*b*) Enlarges the lymphatic glands.
- (*c*) Extends to neighbouring tissues.
- (*d*) Spreads to the respiratory tract.
- (*e*) Evolves bacterial races suited for infection of the bowel, which are swallowed and invade the whole alimentary tract.
- (*f*) Is disseminated by the blood-stream and produces lesions in all parts of the body.

BIOLOGICAL CLASSIFICATION OF THE INDIGENOUS MICRO-ORGANISMS OF THE MOUTH

(See fig. 419.)

The vegetable kingdom is represented not only by bacteria, which are the most primitive known forms of plant life, but also by

members of the higher fission fungi to which belong moulds and yeasts. The most important pathogenic members of this group occurring in the mouth are the *Streptothrix*, a fine branching filamentous organism commensurate with short chains of bacteria, and *Oidium albicans*, which grows in rather coarser septate filaments and causes Thrush. Members of the animal kingdom are frequently present, notably *Amœbæ*, which are irregular unicellular masses, members of the lowest animal forms, the *Protozoa*. They are very much larger than bacteria, and many times as big as a red blood corpuscle.

Yet other forms of life—the *Spirochætes*—are commonly found. They are long, sinuous, motile organisms of bacterial dimensions.

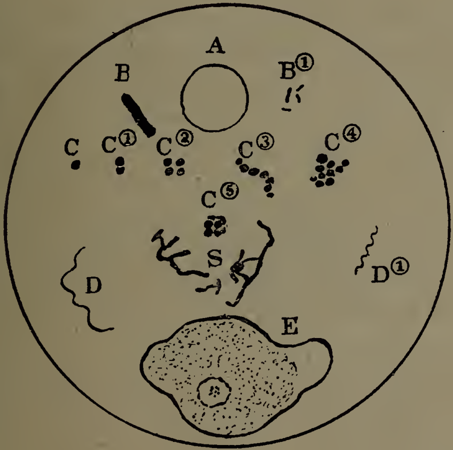

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FIG. 419.—Illustrating the shapes and relative sizes of various micro-organisms. A, red corpuscle; B, large bacillus (*B. subtilis*): B¹, small bacillus (*B. tuberculosis*); C, coccus; C¹, diplococcus (pneumococus); C², tetrad (*Micrococcus tetragenus*); C³, streptococcus (*S. salivarius*); C⁴, staphylococcus (*S. aureus*); C⁵, sarcina; D, large spirochæte (*S. Vincenti*); D¹, small spirochæte (*T. microdentium*); S, tangled filaments of streptothrix (*Actinomyces bovis*); E, small amœba.

They appear to be more closely related to protozoa than to bacteria, but their exact biological classification is still in doubt.

THE STUDY OF BACTERIA IN THE LABORATORY

Organisms can be grown in artificial media at suitable temperatures. The number of culture media which have been invented is very great, and only those of immediate utility will be mentioned. Media may be liquid or solid. Meat broth is the commonest liquid

medium, and it forms the basis of many others, which consist of broth with some added material such as cane sugar, sodium nitrate, &c. Milk is another fluid medium in common use. Important solid media are 10 per cent. *gelatine* in broth, 2 per cent. *agar* in broth, and a similar medium enriched with a little blood. Media are usually kept in sterile test tubes plugged at the top with sterile cotton-wool. Together with all apparatus employed in the conveyance of infected material they are scrupulously sterilized before use.

If a swab carrying septic matter from the mouth is smeared over the surface of a tube of blood agar and the tube is placed in an incubator at 37° C. (body temperature), the bacteria planted on the medium will grow and slowly form visible masses or colonies. Where a colony originates from a single organism its members are all of one type. Such a colony can be removed to a second tube on the point of a platinum wire. After incubation this second tube becomes filled with a pure culture of the organism in question which can be studied in detail. This method is the one usually adopted in separating the bacteria of the mouth from one another for purposes of identification and for the production of vaccines, although numerous special methods have been devised to meet special cases.

Bacteria are of various shapes (see fig. 419):—

(1) Spheres and blunt ovoids known as *Cocci*.

(2) Rods and filaments classified as *Bacilli*.

(3) Spirals which are called *Spirilla*.

Many criteria are employed in the differentiation of the various races. Some of those in common use are given below and serve to exemplify characteristics of bacteria.

(1) Morphology.—Shape and size, whether ensheathed in a capsule or not, whether forming spores or not, staining properties, and motility or its absence.

(2) Cultural Characters.—The appearance of the massed growth on various media; the size and shape of individual colonies; the nature of the media on which growth will take place; the optimum temperature for growth; whether air is detrimental to growth as in *anaerobic* varieties or essential as for *aerobes;* the nature of the decomposition products evolved such as acid and gas; the nature of more elaborate products such as pigments, green, orange, blue, &c.; and ferments. Some bacteria produce ferments capable of digesting gelatine, others digest inspissated blood serum, others coagulate milk, decompose cane sugar, and so on.

(3) Infectivity.—Some bacteria die on injection into healthy laboratory animals, others kill the animal and produce characteristic lesions. Some are pathogenic for one species and not for another.

For details of these methods and bacteriological technique in general, the student must refer to a manual on bacteriology.

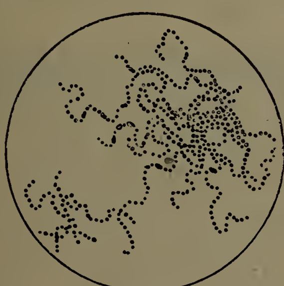
COMMON ORGANISMS OF SPECIAL INTEREST IN DENTAL PATHOLOGY

No attempt will be made to give a comprehensive catalogue of the organisms which have been found in pathological foci in the mouth at various times. Only such will be mentioned as are very conspicuous or are known to be harmful to the teeth and adjacent tissues.

INFECTIVE AEROBES

(1) COCCI

(*a*) Pyogenic cocci. Streptococcus pyogenes, fig. 420 (stains by Gram's method).—Cocci growing in chains of three or more members are called streptococci. There are many varieties of



× 500.

Fig. 420.—*Streptococcus pyogenes.* Note the arrangement of the cocci in long chains. From Besson's "Practical Bacteriology." (Longmans, Green, and Co.)

these, the infective ones being known as *Streptococcus pyogenes.* In laboratory media these infective stains usually grow in long chains of thirty or forty units, and for this reason are often described as *Streptococcus longus.* As a general rule the two terms may be taken as synonyms for the same type of bacterium.[1]

The more virulent species produce acute infections which are prone to spread rapidly along the lymphatic vessels and spaces,

[1] Several much more elaborate classifications have been introduced at various times dividing infective streptococci into numerous sub-groups, but none of these provisional arrangements have up to the present met with universal approval.

giving rise to cellulitis which, starting around the teeth, may involve the cheeks and neck and even the orbit. The tissues involved exude a thin turbid fluid rich in polymorphonuclear leucocytes, but not of that thick creamy consistency popularly associated with pus. Although invasion along the lymphatics is very characteristic of this organism, dissemination often takes place by the blood-stream also. Many fatal cases of septicæmia are of this nature. Some of the most virulent strains secrete powerful hæmolysins which cause hæmoglobin to leave the red corpuscles and circulate in the plasma, where it is destroyed or excreted.

The less virulent members are extremely common in all foci of chronic infection about the mouth, and give rise to a slow tissue destruction with fibrous replacement. They are of very great importance in that the slow escape of cocci from such areas in the mouth and intestines into the blood-stream is the immediate cause of numerous chronic lesions in all parts of the body, particularly of many instances of muscular rheumatism, chronic arthritis, chronic infective endocarditis, anæmia and nephritis. Some of the less virulent strains produce a greenish discoloration when grown on blood agar and are therefore alluded to by many authors as *Streptococcus viridans.*

There are other streptococci of non-infective type and growing in short chains of two to twelve units. They are best termed *Streptococcus brevis*, but when obtained from the mouth are often known as *Streptococcus salivarius.* They are almost universally present in the buccal cavity even in health, and like many of the long-chained varieties are capable of producing considerable degrees of acidity in sugar media. Intermediate varieties exist, and sometimes it is very difficult to decide whether a given coccus is a saprophytic *Streptococcus brevis* or an unusually short and benign member of the *Streptococcus pyogenes* group.

It should be noted that even very pathogenic streptococci which grow in very long chains in laboratory media often grow in short chains in infected tissues.

Staphylococcus pyogenes, figs. 421 and 422 (stains by Gram's method).—These organisms tend to grow in irregular groups or clusters. In the body, however, and in liquid media, most of them are merely arranged in pairs. They grow freely in laboratory media and produce acid from lactose, clot milk, and evolve a feeble proteolytic ferment capable of liquefying gelatin, but unable to digest blood serum. Like streptococci, many species secrete powerful hæmolytic substances. On solid media they produce pigments and

various subgroupings have been based upon the colour of the pigment. Thus *S. aureus* produces a golden yellow, *S. citreus* a pale

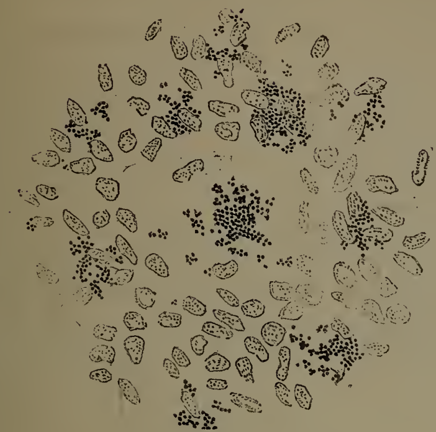


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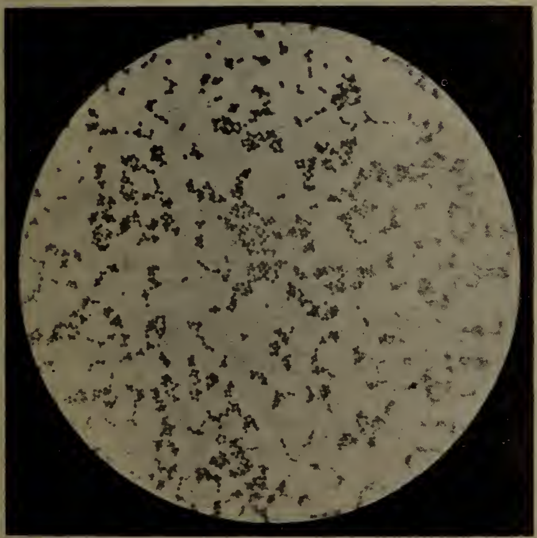
FIG. 421.—*Staphylococcus aureus* in pus. Note the arrangement of the cocci in clusters. From Besson's "Practical Bacteriology" (Longmans, Green, and Co.).



× 1,000.

FIG. 422.—*Staphylococcus aureus*. Taken from a young culture on agar. Note the grouping in clusters and also in pairs.

chrome yellow, *S. albus* an opaque white substance. The first is the most virulent variety and the last the least infective. White forms can almost always be found on the surface of the skin.

A local abscess with thick creamy pus is the most characteristic staphylococcal lesion. The organism is particularly associated with boils, carbuncles, and osteomyelitis. Spreading cellulitis is not so commonly due to this organism as to streptococcus, but secondary abscesses often arise in the neighbouring lymphatic glands. In pyrexial disease it induces a most intense leucocytic response, and the neighbouring tissues become densely packed with polymorphonuclear leucocytes, whilst the number of these cells in the blood may increase from 8,000 to 60,000 per cubic millimetre. It is found in infected mouths, but not so frequently as is the streptococcus.

Pneumococcus, fig. 423 (stains by Gram's method).—The pneumococcus or *Diplococcus lanceolatus* is found in infected tissues as pairs of cocci ensheathed in capsules. The organisms are not true spheres, but somewhat pointed domes with their bases in apposition.

× 925.

Fig. 423.—Pneumococcus. Note the grouping in pairs, the conical shape of the individual cocci and the clear capsules enveloping each pair. From Curtis' "Essentials of Practical Bacteriology" (Longmans, Green, and Co.).

It does not grow vigorously in the laboratory, and on artificial media capsules are not formed. In liquid media chains of four to six members appear, although the dominant grouping is still in pairs.

Attenuated strains of low virulence are sometimes found in chronically infected gums, but the most characteristic lesion is an abrupt severe infection of the tonsils or respiratory tract, frequently involving the alveoli of the lungs, and producing lobar pneumonia. Like the staphylococcus it evokes an intense leucocytic response, and in acute infections can produce thick creamy pus, as in the pleural cavity or in the maxillary antrum.

(*b*) Micrococcus catarrhalis (does not stain by Gram's method).—This coccus grows in clusters. It produces only small concentrations of acid from sugar and does not give out any proteolytic

ferments. It is often found in cultures made from infected gums, but only as an indication of a general buccal infection. As its name implies, its chief infective activity invokes superficial catarrhal inflammations, especially in the mouth and respiratory tract.

(*c*) OTHER COMMON INFECTIVE COCCI sometimes found in the mouth but of no known significance in dental pathology are the *Meningococcus* of cerebrospinal meningitis and *Micrococcus tetragenus.*

(2) BACILLI

(*a*) B. TUBERCULOSIS, fig. 424 (stains by Gram's method and by Ziehl-Neelsen's method).—This organism is a small, slightly curved, non-motile bacillus, occurring singly or in small irregular clumps. It grows very slowly in the laboratory, forming a dry incrustation on

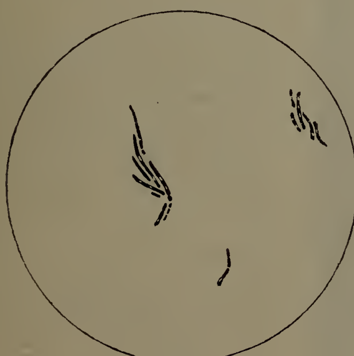


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FIG. 424. — *Bacillus tuberculosis.* Note the slightly curved and beaded character of the bacilli. From Curtis' "Essentials of Practical Bacteriology" (Longmans, Green, and Co.).

solid media (fig. 425). It belongs to the small group of *acid-fast* bacteria, so-called because, after being stained by hot carbol-fuchsin, they resist discoloration by 25 per cent. sulphuric acid. It is commonly found in the mouth in tuberculous affections of the lungs, either floating freely in the secretions or less frequently causing chronic ulceration of the fauces, tongue and gums. The characteristic lesion in the mouth is a slowly spreading deep ulcer with irregular margin and considerable fibrous induration in neighbouring tissues where areas of previous infection are healing. As an infection of importance in dental surgery, it occasionally involves the jaw, producing necrosis. It often plays the part of a secondary invader of

cervical lymphatic glands which have been damaged by the products of chronic oral sepsis and gives rise to tubercular adenitis. Whether the portal of entry of these organisms is the buccal mucosa or by way of carious dentine or in some more remote part of the body has not yet been fully determined. It is probable that each route is employed on different occasions.

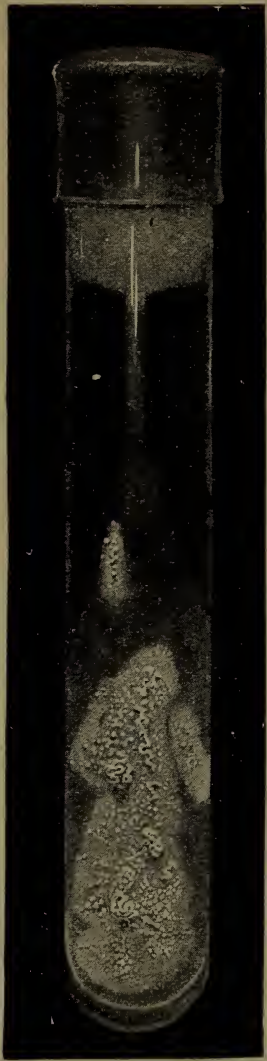


FIG. 425.—Massed growth of *B. tuberculosis* on a glycerine-agar slope. Note the dry wrinkled appearance of the incrustation. From Curtis' "Essentials of Practical Bacteriology" (Longmans, Green, and Co.).

(*b*) *B.* DIPHTHERIÆ, fig. 426 (stains by Gram's method).—This bacterium, also known as the Klebs-Löffler bacillus, is a slightly curved, beaded, non-motile, rod-shaped organism usually found in small irregularly angled groups resembling Chinese characters. When stained with methylene blue it has a very curious barred appearance, stained areas alternating with narrow transverse unstained bands. It usually produces acute ulceration of the fauces or larynx with a covering of white membrane. Occasionally, however, it is found in chronic ulceration which may involve the gum margin. Such cases may come under the observation of the dental practitioner.

Several varieties of diphtheroid bacilli are common in the buccal cavity, sometimes even in healthy mouths. Although non-infective they resemble the Klebs-Löffler bacillus so closely in appearance that, in cases of suspected diphtheria, their differentiation should always be entrusted to a professional bacteriologist.

(*c*) OTHER COMMON INFECTIVE BACILLI found in the mouth, but of no special significance in dental pathology, are:—

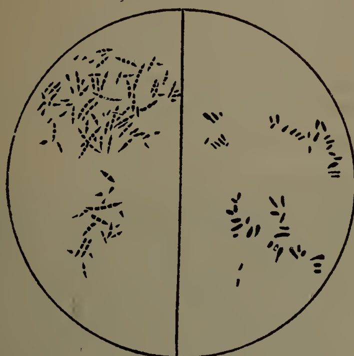
B. pneumoniæ, or Friedländer's bacillus.

B. influenzæ and *B. pyocyaneus*.

(3) STREPTOTHRICEÆ

(*a*) ACTINOMYCES BOVIS, figs. 427 and 428 (stains by Gram's method).—This organism, a streptothrix, grows in irregular branch-

ing filaments which interlace and form small tangled masses. Many of the branches given off from the outer aspects of these central cores are short and characteristically clubbed at their ends. The colony is just visible to the naked eye as a fine sulphur-yellow



× 925.

FIG. 426.—*B. diphtheriæ*—two varieties. Stained with methylene blue. Note the arrangement of the bacilli in small groups, the curved and beaded forms, and the irregular striped distribution of the stain. From Curtis' "Essentials of Practical Bacteriology" (Longmans, Green, and Co.).

× 1,000.

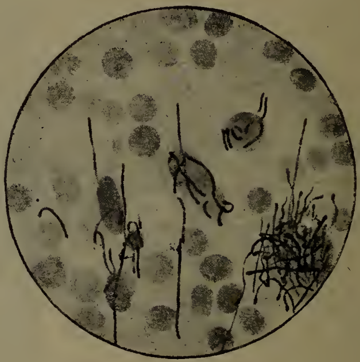
FIG. 427.—*Actinomyces bovis.* From a culture in meat broth. Note the irregular branching filaments.

granule. It grows slowly in the laboratory, forming a scanty hard vitreous nodular mass on solid media and a granular deposit in broth.

It evokes a slow suppurative process with much granulation tissue and a purulent exudate containing peculiar sulphur-yellow

granules. It is much commoner in cattle than in human subjects. The mouth is one of the commonest sites of infection in man. Usually the soft tissues alone are involved, but sometimes the jaw itself is invaded. An indolent hard swelling forms, and eventually the surface breaks and pus is discharged externally or into the mouth. In the course of time a number of sinuses develop leading from skin or mucosa to bone. Some of these sinuses are very intractable. Secondary lesions sometimes form in the intestines, particularly in the vermiform appendix, and occasionally in the lungs. These secondary invasions almost always end fatally.

The streptothrix obtained from such lesions does not always resemble *Actinomyces bovis* in every respect, and probably there



× 530.

Fig. 428.—*Actinomyces bovis* in pus. Note the branching filaments, the tangled masses and the clubs. From Curtis' "Essentials of Practical Bacteriology" (Longmans, Green, and Co.).

are several allied races, each of which is capable of producing similar clinical features.

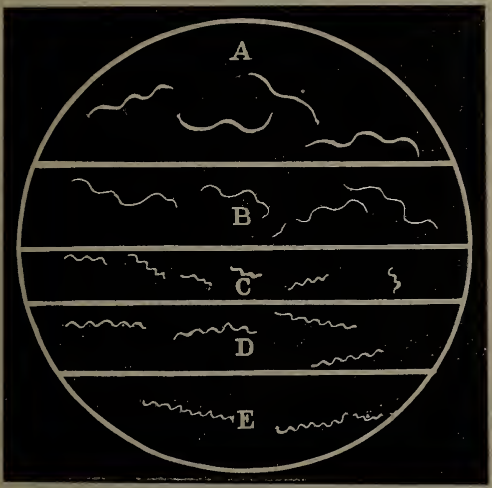
(*b*) Kindred organisms whose pathological import, if any, is still undetermined frequently occur in the mouth, notably *Leptothrix buccalis* and *Cladothrix*.

SPIROCHÆTES (fig. 429)

These micro-organisms cannot be stained by the simple methods employed for bacteria, but most of them can be seen after treatment with warm gentian violet. They then appear as very fine filaments, usually much narrower than bacilli, coiled into spirals of various proportions. They are motile, and progress by violent undulatory movements like an angry snake or with a slow rotary screw-like action. Their refractive powers are such that when

unstained the organisms cannot be seen under the microscope except with the aid of an efficient dark-ground illumination. With one or two exceptions they have resisted all efforts to grow them on laboratory media. They abound in very large numbers in infected areas of the mouth, but no proof of their pathogenicity in these localities has ever been brought forward.

The commonest variety is *Spirochæta buccalis* and its sub-group *Spirochæta refringens*. These are moderately broad organisms with tapering ends and three or four long shallow undulations. They



× 1,000.

FIG. 429.—Spirochætes from the mouth (seen by dark-ground illumination): A, *S. buccalis*; B, *S. Vincenti*; C, *Treponema microdentium*; D, *T. macrodentium*; E, *T. pallida* (syphilis). (Note resemblance to elongated forms of *T. microdentium.*)

adopt the rotary method of progression. They are often present in overwhelming proportion in the pockets between the teeth and the gums in pyorrhœa alveolaris.

Spirochæta dentium is of a much more delicate structure and has been studied by Noguchi, who differentiated it into three sub-groups: *Treponema macrodentium*, *T. microdentium*, and *T. mucosum*, each of which he succeeded in isolating and growing in pure anaerobic culture. They are found in septic mouths and in carious teeth. Their progression is rotary. Their coils are small, close and regular, and may amount to ten in number. In general appearance they often resemble the spirochæte of syphilis. This is particularly true of *T. microdentium*.

VINCENT'S ANGINA (fig. 430).—This is the name given to a virulent form of stomatitis which invades the gums. The affected areas often ulcerate and become coated with yellowish membrane. In the exudate are found large numbers of spirochætes, *S. Vincenti*, in combination with spindle-shaped bacilli, *B. fusiformis*. Very infective strains of *Streptococcus pyogenes* are also present in a large proportion of cases, but the exact parts played by these various organisms is still uncertain.

SPIROCHÆTA VINCENTI is a sluggishly motile organism, composed of four or five very open spirals and closely resembling the common *Spirochæta buccalis*. Many bacteriologists maintain that the two organisms are identical and harmless saprophytes. The chief morphological differences recorded are more irregularity in the coils

× 925.

FIG. 430.—*B. fusiformis* and Spirochætes from Vincent's Angina. From Besson's "Practical Bacteriology" (Longmans, Green, and Co.).

and a greater thinness of *S. Vincenti* as compared with *S. buccalis*. Both organisms have up to the present resisted cultivation in artificial media.

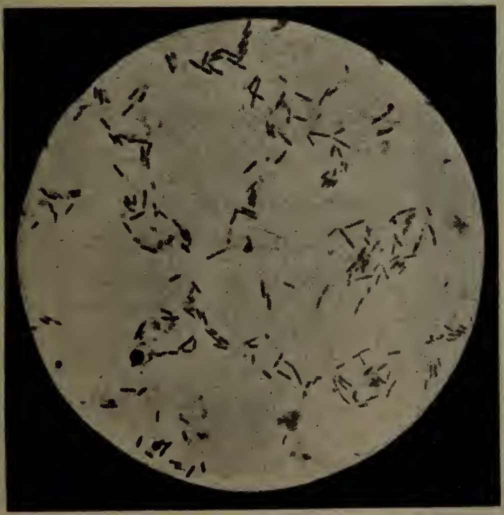
B. FUSIFORMIS is a non-motile slender anaerobe with pointed ends. It does not stain by Gram's method, and is extremely difficult to grow in the laboratory. Its precise nature is doubtful. It has been looked upon by some observers as a developmental form of *Spirochæta buccalis*. It has been found repeatedly in healthy mouths and in minor forms of oral sepsis. Its infective nature has not yet been established, and the injection of pure cultures into laboratory animals is rarely followed by harmful effects.

ANAEROBIC BACTERIA

The classification of these organisms has with few exceptions proved to be too difficult a task for modern bacteriological methods. Two great sub-groups are recognized :—

(1) *Proteolytic Anaerobes.*—In deep-seated abscesses of dental origin numerous varieties of putrefactive anaerobes are often present. They do not act as primary infective agents, but for the most part prey on the débris and sloughs cast off by the energetic

× 1,000.
FIG. 431.—*B. bifidus* of Tissier. Note the bifid and headlet forms.



× 1,000.
FIG. 432.—*B. mesentericus.* From a young culture on agar.

action of their aerobic brethren. From this material they generate poisons and foul odours.

(2) *Saccharolytic Anaerobes.*—These bacteria are unable to destroy native proteins, but decompose sugars with the generation of acids. One of the best known is *B. bifidus*, or Tissier's bacillus (fig. 431). It is the dominant bacterium of the nurseling's stools,

but recently it has also been isolated from the deep layers of carious dentine. It is a rod-shaped organism which sometimes shows a forked or bifid extremity. It stains by Gram's method and is difficult to grow. Its special interest lies in the degree of acidity, which it can generate in sugar media. The hydrion concentration sometimes rises so high that no infective organism can live in the vicinity. It is possible that this acid production promotes dental caries by assisting in the process of decalcification.

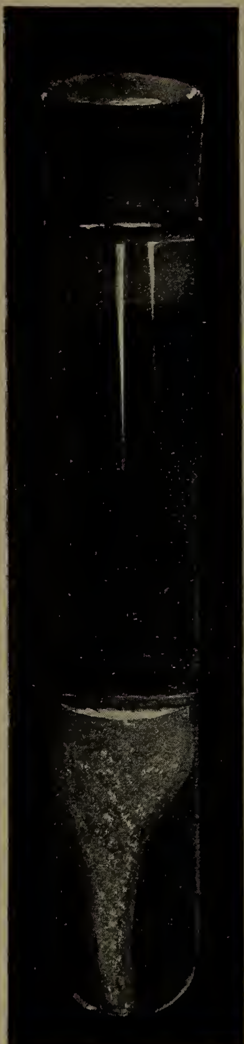


Fig. 433. — *B. subtilis.* Grown as a stab culture in gelatin. Note the large funnel-shaped central area where the gelatin has been liquefied by the proteolytic ferments of the organism. From Curtis' "Essentials of Bacteriology" (Longmans, Green, and Co.).

SAPROPHYTES

These are of numerous varieties, and many of their products impair the vitality of neighbouring tissues. They are found in profusion in the débris of pyorrhœa alveolaris, in all zones of food stasis, and in carious dentine. In the last-mentioned locality they almost certainly assist the infective bacteria in continuing if not in originating the carious process. They are best classified in accordance with the nature of the changes which they can determine in the substrate upon which they live. From the point of view of the pathogenesis of dental caries they fall most aptly into two groups:—

(1) Those forming acids freely from sugar media, e.g., *B. bifidus* of Tissier, *B. acidophilus* of Moro, *Streptococcus brevis*, *sarcinæ*, and occasionally members of the *B. coli* group (aided by acid-forming infective bacteria, such as staphylococci and many strains of *Streptococcus pyogenes*).

(2) Those yielding proteolytic ferments which enable them to prey upon native proteins, e.g., *B. mesentericus* (fig. 432), *B. subtilis* (fig. 433), and many forms of putrefactive anaerobes.

The former group is thought to decalcify the dentine and the latter to

dissolve its protein matrix. All these organisms except *B. coli*, which is of very rare occurrence, stain by Gram's method. *B. acidophilus* of Moro is an aerobe which, like *B. bifidis*, can generate sufficient acid to destroy almost all infective bacteria. It is closely related to the Bulgarian bacillus of sour milk, and is common in all parts of the digestive tract. Sarcinæ are cocci which grow in cubical packets of eight or more members. They occur in many varieties, and are common in air and dust as well as in the mouth. *B. mesentericus* and *B. subtilis* are large rods, and grow with such rapidity that they quickly overgrow most other organisms in laboratory cultures. Like sarcinæ, they are disseminated widely in air and dust.

SIMPLE TECHNIQUE

(1) Bacteriological Diagnosis

Bacteria can be seen either in their unstained living state or after fixation and staining. To obtain sufficient definition for purposes of diagnosis they must be viewed through a $\frac{1}{12}$ in. oil immersion objective, and the light reflected from the mirror must be focussed on to the object by a substage condenser. A firm microscope stand with a fine as well as a coarse adjustment is essential. A mechanical stage can be dispensed with, although it is extremely useful. Before a stained specimen of bacteria can be produced a thin smear or film must be made on a grease-free cover slip or glass slide which has been cleansed by gentle boiling in 10 per cent. chromic acid for twenty minutes. Cover slips which have been subjected to this process should be thoroughly washed in bulk under the tap, then with distilled water, and finally with 97 per cent. alcohol. They are stored in a wide-necked glass-stoppered bottle containing alcohol. From the time they are immersed in the chromic acid onwards they should never be touched by the hands. If at any time fingers are carelessly dipped into the jar instead of clean forceps the whole stock will be ruined, and a fresh boiling in chromic acid the only remedy.

Glass slides can be prepared more quickly by a firm rubbing with the finest emery paper procurable. The result is not quite so satisfactory as that following the chromic acid method.

The cleansing need only be applied to the element on which the film is to be made, e.g., if the film is made on a cover slip, this after being stained can be applied to an ordinary glass slide which has simply been rubbed with a clean duster.

To make a film, remove a slip with clean forceps and burn off the alcohol. By means of a loop of platinum wire place a drop of water in the centre. Sterilize the wire in a Bunsen flame, and use

it to convey a small quantity of the material to be examined to the water already on the cover slip. Make an emulsion by gentle rubbing and spread it evenly. When the film has dried completely, fix it by holding the slip in the fingers and passing it three or four times through a Bunsen flame. It is then ready to be stained.

(*a*) *Tuberculosis* (fig. 424).—Make a film and place it in hot carbol-fuchsin, which should not be allowed to boil. After ten minutes dip the film in 25 per cent. sulphuric acid and wash in water. Wash in alcohol until the washings are colourless. Wash again in water and counter-stain for a few minutes with methylene blue. Wash, dry and mount in Canada balsam.

This is known as the Ziehl-Neelsen's method, and by its means tubercle bacilli appear red, whilst all other bacteria likely to be found in the mouth are blue. The finding of red bacilli is usually relied upon as sufficient evidence that tuberculosis is present. Occasionally in doubtful cases the diagnosis is confirmed by elaborate methods.

(*b*) *Vincent's Angina.*—Make a film and stain for a few minutes in warm gentian violet. Wash in water, dry, and mount in Canada balsam. *B. fusiformis* and *S. Vincenti* are recognized by their characteristic shapes (fig. 430).

The spirochætes can also be seen by placing two or three drops of concentrated aqueous Congo red at one end of a grease-free slide and mixing with it a small portion of the infected material. Smear this emulsion over the rest of the slide in a thin film and allow to dry. Immerse in acid alcohol to change the colour from red to blue and then allow to dry. There is no need to apply a cover slip. The spirochætes appear as clear wavy lines on a finely granular grey-blue background.

These methods usually suffice to establish the diagnosis.

(*c*) *Streptococcal Infection.*—Stain a film with cold aniline gentian violet for five minutes. Wash in water, treat with Lugol's iodine solution for half a minute. Wash in water, and then in alcohol until the washings are colourless. Wash again in water, and stain for five minutes in neutral red. Wash in water, dry and mount. This is Gram's method of staining.

Streptococcus pyogenes (fig. 420) and many other organisms are coloured a deep purple-black. Mingled with them are usually many *Gram-negative* bacteria stained red. Black cocci in chains of more than twelve units indicate infection by *Streptococcus longus*. Should streptococci be seen only in short chains, material must be sent to the laboratory for cultivation before a diagnosis can be established, because *Streptococcus pyogenes* often appears in short chains in

body exudates, and is indistinguishable from *Streptococcus brevis* until cultural tests have been employed.

(*d*) *Other Infections.*—Other infections cannot often be diagnosed without laboratory equipment for growing and isolating bacteria. In many cases facilities for performing animal inoculations are needed also.

FIG. 434A.—Swab suitable for conveying infected material from the mouth to a culture tube.

(2) THE COLLECTION OF MATERIAL FOR CULTURAL INVESTIGATION AND THE INOCULATION OF TUBES OF MEDIA

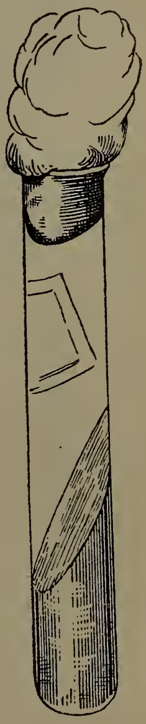


FIG. 434B.—Culture tube containing agar. Note the sloped surface of the medium over which infected material can be smeared conveniently. From Ellis' "Outlines of Bacteriology" (Longmans, Green, and Co.).

All apparatus used in conveying infected material must be sterilized scrupulously. Loops of platinum wire are made red hot and allowed to cool immediately before use. Probes and other metal instruments should be boiled for at least five minutes, and used as soon as they are cool enough to hold. Fig. 434A shows a swab which is very commonly employed. It is a light wooden rod about 5 in. long and as thick as a match. A small piece of cotton-wool is twisted round one end, and the whole placed in a test-tube plugged tightly with cotton-wool and sterilized for a few minutes in an oven at 175° C. Fig. 434B shows a test-tube containing nutrient agar which has been allowed to solidify at such an angle as to produce a sloping surface suitable for inoculation. The medium and the tube are sterilized separately, and after the slopes have been made their sterility is tested by incubation for twenty-four hours.

To inoculate a tube of medium choose a place absolutely free from draught and far from any open window or door. Ignite the cotton-wool plug and then extinguish by blowing. In this way bacteria and dust collected on the lip of the tube and lying loosely in the plug are destroyed. Hold the tube in the left hand almost horizontally so as to prevent dust from falling into it when the plug is removed. Secure the infected

material on a sterile platinum loop, probe, or swab, held in the right hand. Grasp the plug of the tube of medium between the little finger and the palm of the right hand and gently remove it with a screwing action. Smear the infected material lightly over the surface of the medium, taking care not to soil the mouth and sides of the tube. Remove the swab or instrument. Pass the mouth of the tube through a Bunsen flame, and replace the plug as quickly as possible. If a swab is employed the plug of its tube is ignited before removal, the swab is returned after use, and the plug replaced again. Instruments should be sterilized in a flame or boiling water before being replaced on the bench. Should the deep part of the plugs touch anything, or should dust blow or fall into the tube, or should the cotton-wool end of the swab touch anything other than the infected focus and the medium even for the fraction of a second, the inoculation will prove useless, and the pathogenic bacteria will be overgrown by various prolific air-borne organisms. Tubes of media keep for several months if covered with indiarubber caps and placed in a cool, dark cupboard or drawer.

(a) *Pyorrhœa Alveolaris and Gingival Infections.*—Clean away all visible débris such as tartar and scale the teeth if necessary. Wipe the gum margin and adjoining tooth with a pledget of sterile cotton-wool. Press on the gum with a sterile instrument or swab. On another sterile swab collect the bead of pus which exudes and smear it over the surface of an agar slope, or if available, a blood-agar slope. Send at once to the laboratory. Should immediate dispatch be impossible, keep the swab in a cool place and the agar slope in a warm place (temperature not above 37° C.). It can be placed conveniently in a vacuum flask into which a little warm water has been poured. Diagnosis is facilitated by preparing a film of the fresh material and sending it to the laboratory at the same time as the tubes. An even better method is to pass a loop of platinum wire previously heated in a flame and cooled, or a fine sterile probe, between the gum and the tooth, and to use this to inoculate the culture tube. On no account should antiseptics be allowed to contaminate the infected area or any of the instruments because they depress bacterial activity, and the inoculated tube may therefore fail to yield any growth.

(b) *Extracted Teeth.*—It is often desirable in cases of systemic disease secondary to oral sepsis to obtain cultivations from the deep tissues where the infective organisms are most active and uncontaminated by the saprophytes which abound in the surface débris.

In such a case cleanse the tooth and gum as thoroughly as possible and remove tartar and other visible deposits before perfoming the extraction. Do not allow the tooth to touch the cheeks or lips during its passage from the mouth. Before releasing it from the forceps rub the roots with a sterile swab, taking care not to touch any other part, and use the swab to inoculate an agar slope tube. Let the tooth fall root downwards into a sterile tube. Keep the culture warm and the tooth and swab cool, and dispatch as soon as possible. Avoid shaking the tooth in its tube, otherwise the root areas may be contaminated by the sides of the tube which have been in contact with the other portions of the tooth.

(*c*) *Pus from Abscesses.*—Samples may be removed on swabs and media inoculated in the ordinary way. The most satisfactory method, however, is to use a pipette shaped as in figure 435.

It is made of $\frac{1}{4}$-in. glass tubing sealed at A, plugged at C with cotton-wool, and sterilized in an oven at 175° C. To use it the end A is broken, passed slowly through a flame and dipped into the pus. Suction is applied at D, preferably with a rubber teat. When sufficient material has been collected the tube is sealed in a flame at A and B, kept cool, and dispatched as soon as possible. Another convenient method is to draw out a piece of glass tubing in a flame so as to make a small length of capillary tube. Seal and sever the narrow portion by applying more heat at each end. The heat used in the manufacture of this doubly closed capillary tube suffices for its sterilization. To use it, break off each end, pass one end through a flame, and dip it into the pus which enters by capillary attraction. When a suitable sample has been obtained, seal off each end in a flame, keep in a cool place, and dispatch as soon as possible.

Fig. 435.—Pipette suitable for the collection of pus and other infected exudates. From Curtis' "Essentials of Practical Bacteriology" (Longmans, Green, and Co.).

(*d*) *Suspected Cases of Diphtheria.*—Inoculation should be made on to a slope of inspissated blood serum, not on to agar. In this way the accuracy of the subsequent examination is greatly facilitated.

THERAPEUTICS

Antiseptics and Germicides

These are substances which kill bacteria or arrest their activity. A great many different kinds are in use and serve different purposes. For steel instruments a non-corrosive antiseptic such as lysol must be used; for the skin a non-irritant such as equal parts of alcohol and 6 per cent. iodine solution; whilst for delicate mucous membranes still less irritant solutions are required. For the alimentary tract the drug must be unabsorbed or else non-toxic after absorption in the doses given. Such a substance is ichthyol. For the tissues and the blood-stream not only should a non-toxic material be used, but one which remains active after absorption and does not coagulate proteins. Such drugs are provided by the essential oils, neo-kharsivan and many colloidal preparations. The chief uses of antiseptics in dental practice are for the sterilization of apparatus and for the destruction of bacteria in the surface exudates and débris of the mouth. Almost all antiseptics in common use fail to affect bacteria which are actually in the tissues. Few of them can penetrate the surface, and the activity of many is destroyed by the precipitating action of the proteins. However, if the surface is kept clean the vital immunity mechanisms are given better opportunity of eradicating the invading bacteria. Many antiseptics are injurious to the cells of the body, and care should be taken that in cleansing the surfaces tissue resistance is not impaired locally. Therefore sterilize the débris and dead matter, but pay due regard to the vulnerability of adjacent structures.

Autogenous Vaccines

Nature.—These products are simply suspensions of dead bacteria obtained by cultivation from the patients' own infected tissues. They are quite distinct in character from the *vaccine* used as a protective inoculation against small-pox.

Preparation.—The methods of collecting infected material and the simple principles employed in the separation of the various organisms present have already been described. To a pure twenty-four hour culture of the bacterium concerned grown on a solid medium is added a little sterile saline, and a suspension made by rubbing the surface of the medium with a sterile loop of platinum wire. This emulsion is poured into a sterile tube containing a few glass beads and vigorously agitated on a mechanical shaker. A very uniform distribution of bacteria is in this way secured and their numbers per cubic centimetre are counted. The organisms are then

killed by being placed in a water bath at 60° C. for an hour. Suitable dilutions are made with ½ per cent. carbolic acid, and appropriate doses put up in ½ and 1 c.c. ampoules, which are heated at 60° C. for a further period of half an hour. The doses usually employed vary from 2 to 250 millions, but in certain cases much larger numbers of dead organisms are injected, especially as a *prophylactic* or protective measure to non-infected subjects.

Administration.—Injection is made into the subcutaneous tissue, preferably in the abdominal wall or over the trapezius muscle. The skin is painted with iodine, and a perfectly sterile hypodermic syringe with a glass or metal plunger used for the operation. A high degree of asepsis is desirable. The site of the puncture is repainted after the injection and no other application is needed.

Results.—The immediate effect is to lower the patient's resistance somewhat to the organism in question, and during the succeeding twenty-four hours the symptoms of the disease may be aggravated. This is known as the *Negative Phase.* It is followed by the *Positive Phase*, during which the injected proteins are neutralized, and an excess of anti-bacterial substance produced which is available to combat the living organisms at the site of infection.

Dosage.—The dose is adjusted by trial, so that the aggravation of symptoms in the negative phase is just imperceptible to the patient. In chronic non-pyrexial infections the vaccine can usually be given at weekly intervals in slowly increasing doses. As a general rule, if the symptoms fluctuate, injections are made during the periods of partial quiescence. In pyrexial disease much harm can be done by faulty dosage at unsuitable times. In such cases administration should be under strict clinical and bacteriological control.

Recently a more complex variety of preparation known as a *sensitized* vaccine has been used with conspicuous success, especially in chronic streptococcal infections. Vaccines maintain their potency for four or five months after their manufacture.

Stock Vaccines

When the nature of the infecting organism is known or suspected, but cultures of it are not available, stock vaccines are often employed. They are made from a mixture of several strains of the same organism secured some time previously from different sources. As a rule they are not so efficacious as autogenous vaccines. They can be used as diagnostic agents, aggravation of

symptoms after the injection of one of these vaccines indicating infection by a similar race of organisms.

Tuberculin

Many varieties of tuberculin have been devised. They are chiefly derived from dead cultures of tubercle bacilli and are closely akin to vaccines. Their use is limited to apyrexial patients. They invoke a long negative phase, and injections are usually not given more frequently than twice a month. When wrongly used their capacity for harm is great, and their administration calls for experience and skilled clinical observation.

Serums

Several different kinds of horse serum are procurable, and each has its own special use. Some are antitoxic and others anti-bacterial. The former are prepared by injecting horses with increasing doses of bacterial toxin and the latter by injecting them with dead organisms, then attenuated living organisms, and finally with virulent strains of the living bacteria in increasing doses. Horses which have been treated in this manner are kept and bled periodically. The serum is obtained from the blood and stored in sterile ampoules of about 10 to 50 c.c. capacity. If an animal is given a lethal dose of toxin or bacteria and at the same time the corresponding anti-serum is administered, the animal escapes all ill-effects. This phenomenon is made use of in standardizing sera whose strengths are then described as of so many thousand units.

Anti-diphtherial serum is antitoxic and neutralizes diphtheria toxin, but does not kill the bacilli. Gas gangrene serum and tetanus serum are of a similar nature. Anti-streptococcal serum is anti-bacterial and antitoxic.

They can be administered without risk even to patients with high pyrexia, because their injection is not followed by any negative phase, and further quantities can be given after the lapse of a few hours. It is impossible to fix any upper limit for the dosage. 12,000 units are usually regarded as a large dose, although much more can be given.

The serum is injected with a syringe subcutaneously, intra-muscularly and intravenously into the median basilic vein, strict precautions for maintaining asepsis being employed. Polyvalent anti-streptococcal serum, that is to say, one in the preparation of which cocci from many sources have been employed, is of most interest in dental practice. As already indicated, *Streptococcus pyogenes* is the commonest organism to infect the tissues through

lesions in the gums and adjacent structures, and its corresponding serum can be used with advantage in most cases of severe pyrexia which are secondary to such streptococcal invasion.

USEFUL BOOKS ON BACTERIOLOGY

EYRE. "Bacteriological Technique."
JORDAN. "General Bacteriology."
MUIR and RITCHIE. "Manual of Bacteriology."
BESSON. "Practical Bacteriology, Micro-biology, and Serum Therapy." (A manual of bacteriology as well as a laboratory guide.)

CHAPTER XI

Injuries of the Teeth arising from Trauma: Concussion, Dislocation, and Fracture

(A) CONCUSSION

Concussion may give rise to slight or severe periodontitis and may be complicated by pulpitis which may lead to death of the pulp. The pulp may be ruptured from its connections at the apical foramen, and when this occurs the pulp often remains quiescent, but marked discoloration of the tooth substance usually supervenes.

(1) Causes.—Concussion of the teeth may arise from direct or indirect violence. Examples of the former occur from a blow of the fist or from a cricket ball, while a fall, a blow on the chin, jumping upon the heels instead of the toes, are examples of the latter.

(2) Signs and Symptoms.—In most cases of concussion of the teeth the patient will be found to be suffering from periodontitis more or less severe. Where the pulp has not been ruptured at the apical foramen, or the inflammation of the periodontal membrane has not extended to the pulp, the tooth will be found to be sensitive to pressure and will respond to thermal changes in the same way as the normal tooth. Should the inflammation spread to the pulp, the tooth will become exquisitely sensitive both to pressure and to slight variations of temperature, the periodontal pain being dull, constant, and restricted to the tooth, while the pain arising from the inflamed pulp will be of a sharp lancinating character and will be referred at times to other teeth and adjacent parts. When suppuration in the pulp occurs, the tooth will no longer be sensitive to changes of temperature, but the periodontal inflammation will increase in severity owing to the suppuration having spread to the periosteum. The pain will be of a throbbing character.

(3) Treatment.—The treatment will depend upon whether or not the pulp is involved in the injury. *When the periodontal membrane only is affected,* local depletion will be found efficacious: in mild cases, counter-irritation, with capsicum plasters, tinct. iod.,

will be sufficient. *When suppuration of the pulp has taken place,* the pulp chamber must be opened in the direction which will render removal of the pulp most easy; the dead pulp must be removed and the canals treated and filled. Where concussion has caused pulp irritation, and at the end of two or three days no improvement is apparent, the pulp should be removed, as prolonged efforts to save the pulp are nearly always followed by periodontitis of an intractable type. The following case is instructive: A patient, aged 12, fell and fractured a tooth, the right maxillary central, and lacerated the pulp. The left central was implicated by concussion. The pulp from the right central was removed, and attempts made to save the pulp in the left central, which was irritable. The periodontitis around the right tooth rapidly cleared up, but continued with the left tooth. As the pulp condition failed to disappear at the end of three weeks, the canal was cleared of the morbid pulp, sterilized and filled. Chronic periodontitis continued in spite of repeated and various treatments for four years, so that removal of both teeth was decided upon. A skiagram of the teeth showed that the root of the tooth originally fractured had been attacked by rarefying periodontitis on the aspect adjacent to the left tooth, and the root of the latter had, to a great extent, disappeared from a similar periodontal condition. If the pulps of the teeth had been removed within a few days of the injury it is probable that the periodontitis would have passed away and the teeth would have been permanently saved.

(B) DISLOCATION

(1) Erupted Teeth.—By dislocation is understood accidental displacement of a tooth from its normal position in its socket. Dislocation may be either partial or complete, that is, the tooth may be forced into or loosened in the socket, or it may be totally displaced from its socket.

(*a*) **Causes.**—Dislocation, like concussion, is the result of violence, but the injury causing dislocation is usually of a more severe nature.

(*b*) **Treatment.**—*When the dislocation is partial*, the tooth should be replaced, the broken alveolar process moulded around it, and counter-irritants applied to the gum. With all dislocations, precautions should be taken to keep the tooth fixed, either by ligatures of silk or wire, or by a splint made of a suitable metal. *If the tooth is driven into the socket*, it should be grasped with a fine-bladed pair of forceps and carefully drawn into place. When

a tooth is driven upwards towards the maxillary sinus, it is probably a safer plan to leave it alone rather than attempt its removal. If removal is considered advisable, care must be taken to prevent the complete displacement of the tooth into the maxillary sinus in the attempt at removal.

If the displacement is complete, the treatment will vary according to the age of the patient and the time at which the case is seen subsequent to the accident. In the young, if seen directly after the accident (as, for example, when the tooth is displaced in the operating room), the tooth should be replaced at once, as under these conditions union of the structures entering at the apex may

Fig. 436*a*.—Mandibular incisor.

Fig. 436*b*.—Mandibular incisor.

Fig. 436*c*.—Maxillary central incisor.

Fig. 437.—Maxillary first premolar.

Fig. 438.—Mandibular premolar.

Fig. 439.—Mandibular premolar, from specimen in possession of G. G. Campion.

take place (see Diseases of the Pulp, p. 432). If the patient is an adult, or is seen some hours after the accident, the pulp of the injured tooth must be removed and the canals sterilized and filled before the tooth is replaced.

(2) Unerupted Teeth.—The permanent teeth may be injured in their crypts from traumatism, the portion of the tooth already calcified being partially separated from the portion which is developing. The condition is analogous to forcible separation of the epiphysis from the shaft in a growing bone.

The calcified portion of the tooth is usually dislocated in such a manner as to form an angle with the developing portion (see figs. 436, *a* to *c*). In the case of premolars the calcified portion occasionally appears to be forced into the developing part, causing a kind of impacted dislocation (see figs. 437 to 439). It is possible that this condition is at times due to careless removal of the deciduous teeth. Dislocation of unerupted teeth is more common in the anterior teeth, since they are more exposed to injury. Injury to the developing maxillary canine is rare owing to the position it occupies in the bone.

The injury may occur either to the crown or to the root, according to the period when the injury was received.

Fig. 440.

When erupted, injured teeth often present a marked bulging at the neck, and marked mobility, and it is at times possible to trace the root through the alveolar wall. Teeth which can be felt high up in the alveolar wall, and which fail to erupt, may be suspected of having been injured.

A case was recorded by J. Lewin Payne[1] in which the mandibular right first premolar was in two pieces, as shown in fig. 440. The upper part of the lower fragment was cone-shaped and fitted accurately into the hollowed-out base of the upper fragment. The pulp cavity in the upper fragment was completely obliterated by

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[1] *Proc. Roy. Soc. Med.*, Odonto. Sec., vol. v, p. 141.

"adventitious dentine," the pulp in the lower fragment being uncalcified. It seems possible that the condition of the tooth was the result of trauma.

(C) FRACTURE

Fractures of the teeth may vary from slight cracks or fissures of the enamel to extreme comminution of the whole tooth tissue.

They may be grouped as follows:—

(*a*) Fractures of the crown. (i) Without loss of tissue.
 (ii) With loss of tissue.
 (*a*) Not involving the pulp.
 (*b*) Involving the pulp.

(*β*) Fractures of the root.

(*γ*) Fractures of both the crown and the root.

(*δ*) Comminuted fractures.

(1) Causes.—The causes of fractures are generally direct or indirect violence, such as a blow from a cricket ball, a kick from a horse, blow on the chin, &c.

With advance in age increased calcification of the soft tissues of the teeth takes place, and this progressive change renders the teeth more brittle, and therefore more liable to fracture. This accounts for the fracture of teeth which occasionally occurs in elderly people during mastication. An example may be quoted. A man, sixty years of age, during mastication, fractured the maxillary left first premolar. He possessed the full complement of teeth, and there was no caries and very slight periodontal disease. The tooth was split in a mesio-distal direction through the fissure on the occlusal surface, the split continuing in a vertical direction upwards to the bifurcation of the roots. An examination of the tooth after extraction showed extreme translucency of the tissues, indicating considerable calcification of the soft tissue of the dentine.

(2) Treatment.

Group (a)—Without loss of tissue.—In these cases the enamel only is slightly cracked or fissured, and there is no loss of substance. No treatment is required.

With loss of tissue and not involving the pulp.—If the fracture involves only enamel, it will be necessary to smooth the rough edge or edges with suitable instruments and polish the surface. Should the dentine be exposed, it may be found hyper-sensitive, especially in young patients. There may also be hyperæmia of the pulp, characterized by extreme sensitiveness to heat and cold, and pain on pressure owing to the congestion extending to the peri-odontal membrane around the apex. The treatment is to employ

counter-irritants or local depletion, at the same time to apply to the exposed dentine local remedies, such as absolute alcohol, nitrate of silver, or chloride of zinc. The symptoms usually subside and at a later period the tooth and its neighbour should be trimmed in such a way as to reduce the disfigurement as far as possible. Should suppuration occur in the pulp from continued irritation, the pulp cavity must be opened and treated in the usual way.

With loss of tissue and involving the pulp: Maxillary central incisors.—The treatment will depend upon—

(i) The stage of the development of the root.

(ii) The sex of the patient.

(iii) The presence or absence of a crowded condition of the teeth.

(i) *The Stage of the Development of the Root.*—The formation of the root of the central incisor is usually complete at about the age of ten years, and that of the lateral incisor at about the age of ten and a half years. A skiagram should be obtained if there is any doubt as to the stage of formation of the root.

If the formation of the root is incomplete the tooth should be removed. The question then to be decided is whether it is better to allow the space to close and to disregard the personal appearance or to retain the space for purely æsthetic reasons, a denture with all its attendant disadvantage to the other teeth being inserted at a later period. When fractures occur after the completion of the root, the pulp should be removed and the canals treated; crowning can then be carried out at a future date.

(ii) *The Sex of the Patient.*—The loss of an incisor to a boy is of less æsthetic importance than to a girl.

(iii) *The Presence or Absence of Crowding of the Teeth.*—Where there is doubt whether to save or remove a fractured tooth, the condition of the teeth as regards crowding is an important consideration. If the teeth are crowded there is a reasonable probability that the space created by the loss of the tooth will close up completely, but, if there is no crowding, it is highly probable that the space will remain permanently. Each case must be treated on its merits. The following comments may be useful.

In *fracture of a maxillary central incisor in a boy before the root is fully formed*, removal of the tooth is to be recommended. In a boy the æsthetic question does not outweigh the advantages of avoiding a denture.

Fracture of a maxillary central incisor in a girl before the root is fully formed.—The tooth should be removed and the interval retained by an appliance attached to the approximal teeth (fig. 441).

In constructing this appliance, care must be taken that the bands around the teeth are clear of the gingival margin. A denture should be inserted when the premolars and canines are in position.

In making dentures for this type of case, the best method is to attach the artificial tooth to a thin vulcanite plate which should cover the greater part of the roof of the mouth, thus avoiding all kinds of clasps.

The disadvantage of a small metal plate is that it is necessary to retain it by means of clasps, and as the clasps must be taken between the teeth the interproximal spaces are damaged.

Fig. 441.

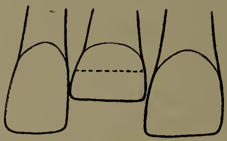

Fig. 442.

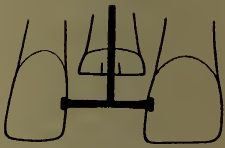

Fig. 443.

Fracture of a maxillary incisor after the completion of the root.—If the teeth are crowded, the better plan is to remove the fractured tooth. In the case of a boy the approximal teeth should be allowed to close together, but in the case of a girl the space should be retained. If the fracture is in the position shown in the diagram, fig. 442, the neighbouring teeth will not tend to approximate. If the fracture is near the region indicated by the dotted line, there will be a tendency for the neighbouring teeth to approximate. Steps must be taken to keep them apart by means of a stay fixed in the pulp chamber (fig. 443).

Maxillary Lateral Incisor.—Where the tooth is fractured before the root is fully formed resort should be made to extraction. In

the case of a girl the appearance of the slightest crowding of the teeth on the opposite side of the mouth should be relieved in order to prevent as far as possible the centre of the mouth shifting (see p. 165). Fracture subsequent to the period at which the growth of the root is completed should be treated by removal of the pulp and the filling of the pulp canal. The tooth then can be crowned at a suitable age.

In cases of fractured maxillary lateral incisors in crowded mouths, the removal of the tooth may be advisable. Judgment must be guided by the sex of the patient and the direction of the root of the canine.

Mandibular Incisor.—In almost every case removal is best. The space, even if it does not completely close, is not very noticeable.

Fracture of a canine, premolar or molar should be treated by removal of the pulp and restoration of the tooth by suitable means.

Groups (β) and (γ)—Fractures of the root or the crown and root should be treated by extraction.

Group (δ)—Cases of comminuted fracture are generally caused by severe violence. Several teeth are usually involved, and the alveolar process is generally fractured. In these cases it is better to reflect the muco-periosteum from the surface of the bone and obtain a view of the area of fracture. The fragments of teeth and bone can then be removed and the muco-periosteum returned and secured in place by sutures.

(3) Healing of Fractured Teeth.—Union of fractured teeth may take place and a few cases have been recorded. The union is similar in character to that which takes place in bone. In a case quoted by Wedl, and shown in his "Atlas of Pathology,"[1] union was effected by means of the periodontal membrane and the pulp.

A rare example of union of a fractured tooth was recorded by Storer Bennett.[2] A maxillary incisor had been fractured across the crown. The patient was 17 years of age, and ten months previously had fallen down, struck the tooth and dislocated it upwards, when it became impacted and remained until removed owing to pain. The tooth is shown in figs. 444 and 445. The bond of union is of a cavernous character with numerous spaces for blood-vessels (see fig. 446).

Fractured roots are more likely to unite when the fracture is

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[1] "Atlas to the Pathology of the Teeth" (Second Edition), 1893, figs. 109 to 111.

[2] *Trans. Odonto. Soc.*, vol. xxviii, p. 181.

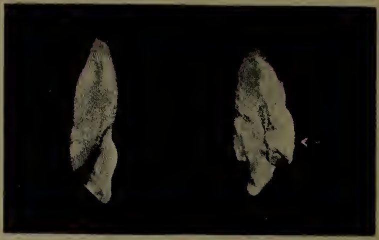


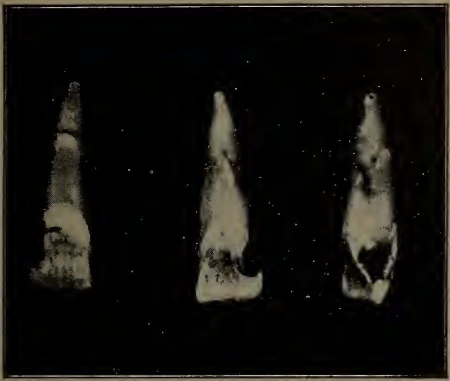
FIG. 444.[1]—The two outer surfaces of tooth from which the section (fig. 446) was removed.

FIG. 445.[1]—The inner surfaces of the preceding figure (fig. 444).

FIG. 446.—From a photomicrograph lent by F. J. Bennett.

[1] From *Trans. Odont. Soc.*

near the apex, because the fragments are kept in fairly accurate apposition by the socket of the tooth. An excellent example is



Anterior Posterior Distal
surfaces.

FIG. 447.[1]

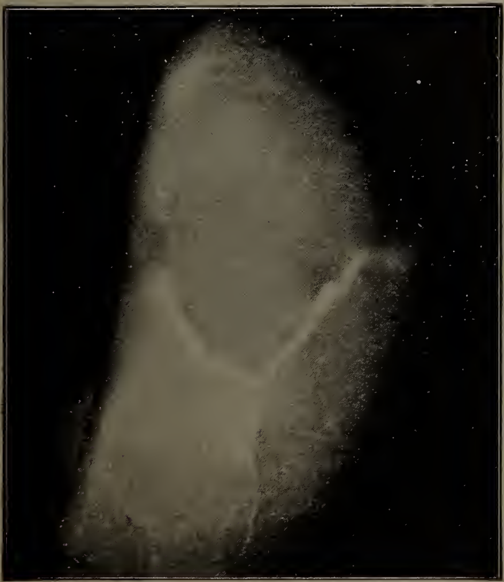


FIG. 448.[1]—Showing groove on surface of root.

recorded by G. W. Watson.[2] The right maxillary central incisor of a man, aged 24, was loosened by a blow from a cricket ball.

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[1] From *Dental Record*.
[2] *Dental Record*, May, 1906, p. 216.

The tooth remained loose and painful for a month after the injury and was slightly misplaced inwards, but eventually became firm and serviceable again. About six years subsequently the tooth was removed, and it was then seen that the blow had fractured the root and repair had followed. The appearance of the tooth was as follows: " About a quarter of an inch from the apex of the root on its labial surface there was a deep, somewhat irregular crescentic groove, continued halfway round the median and distal surfaces. Radiating from these two points and extending round the lingual surface of the tooth was a series of comminuted fractures running in all directions." Illustrations of the tooth are shown in figs. 447 and 448.

CHAPTER XII

Caries of the Teeth.

Prevalence of Caries—Frequency in Individual Teeth—Morbid Anatomy and Pathology—Spontaneous Arrest of Caries—Experimental Reproduction of Caries—Susceptibility and Immunity to Caries—Etiology—Symptoms

Of all the diseases to which human beings are subject, caries is by far the most prevalent. It is found in all races of mankind past and present, but more particularly in civilized races.

(A) PREVALENCE OF CARIES

(1) Ancient Races

J. R. Mummery[1] examined skulls from "the ancient tumuli of Wiltshire and other parts." In 68 skulls from the older Wiltshire tumuli, which date back to the Stone Age, only two cases of caries were discovered, one on an approximal surface and one on an occluding surface. These people were a pastoral and not an agricultural race. They lived by the chase and their customs were barbarous. Among 44 skulls of a similar race inhabiting more northern districts of England, 9 cases of caries were found, 4 on occluding and 5 on approximal surfaces. In 32 skulls of a later race (Bronze Period), there were 7 cases of caries, 6 on approximal and 1 on occluding surfaces. (This race was probably the agricultural population of the maritime districts referred to by Cæsar in his "Commentaries.") The skulls of Romans found in England also furnish ample evidence of caries. In 143 examples, about 32 per cent. exhibited signs of caries, and in one instance the disease was extensive. Passing to the Anglo-Saxon period, we find that out of 76 skulls caries was present in 12.

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[1] *Trans. Odonto. Soc.*, vol. ii, N.S. Over 3,000 skulls were examined, and of these, 1,658 were tabulated, the remainder being rejected either in consequence of their doubtful authenticity, or because too many teeth were missing. This work of J. R. Mummery entailed a vast amount of labour, and is one of the most valuable contributions to the dental literature of the sixties.

Egyptian mummies to the number of 36 were examined, and, in 11, signs of approximal decay were present.

(2) Existing Primitive Races

In an examination of existing primitive races, Mummery found evidence of caries in all of those of which statistics are given. His statistics also bring out the fact that caries is more prevalent in races existing wholly or mainly on vegetable food than in races whose diet consists chiefly of meat.

The following is a *résumé* of the section of Mummery's paper dealing with existing primitive races :—

The Esquimaux, a people of nomadic habits inhabiting the littoral in the extreme north, living almost entirely on a meat diet, of which huge quantities —10 to 14 lb. per person—are consumed daily. In 69 skulls examined, only one case of caries was found. In another instance, two molars had been removed.

The Indians of the North-west Coast of America, whose diet is chiefly dried fish. In 51 skulls two cases of caries were found.

North American Indians (interior). Diet—meat, with occasional addition of roots. Often subject to great privation. Twenty-one skulls showed two cases of two carious teeth in each.

The Gauchos, a mixed race of Indian and Spanish blood in the Argentine Republic, occupied on ranches and living mostly on horseback. Diet—entirely "roast beef," with Paraquay tea taken without sugar as their sole beverage. No record of skulls examined is given, and only one case of toothache could be traced.

In Indians of the same race inhabiting the towns and indulging greatly in artificial diet (acid confectionery and inferior wines, &c.), caries was prevalent.

Arabs of the Nubian Desert, living on a diet consisting almost wholly of the milk and flesh of camels, possess, according to observers, sound and well-formed teeth.

The Fiji Islanders, a robust race, addicted to cannibalism. In 38 skulls there were only two instances of caries, in one case two teeth being affected and caries being extensive in the other case.

The New Zealanders, whose habits resemble the Fijians. In 66 skulls there were two cases of caries, in one of which two teeth and in the other four were affected.

The Inhabitants of Eastern Polynesia. Diet—vegetable products and fish. In 70 skulls there were eight cases of caries, a large proportion of them being extensive.

The Sandwich Islanders. Diet—mainly vegetable with small amount of meat. In 21 skulls there were four cases of caries, two of which were very extensive.

The Australian Races. "For the most part improvident savages, and spending their lives in alternate feasting and famine." Diet—mainly meat. 132 skulls showed 27 cases of caries, some being extensive.

The Tasmanian Race closely resembles the Australian in habits. In 33 skulls examined nine cases of caries were found, and, in the majority of these, a considerable number of the teeth were affected.

The Zulu Kaffirs. Diet—milk and vegetables, meat being consumed on special occasions, as in the training of their warriors. In 49 skulls there were seven instances of caries, five of which were of very limited extent.

The African Tribes which supply the Slave Markets. The most feeble of the African tribes, mainly inhabiting unhealthy districts. Diet—mixed, principally vegetables. The skulls of 268 slaves who had died of disease or exhaustion were examined. In 66 caries was present, many of the cavities being in approximal surfaces. In no less than 16 of the cases the whole of the molars and premolars were carious.

The Bushmen. Dwarfs inhabiting the deserts of South Africa. Diet—chiefly meat, but in times of scarcity edible roots, locusts, &c. In 29 skulls six cases of caries were found, the majority being extensive.

The Natives of Southern India. Diet of a varied character, frequently of an unwholesome nature. Rice forms the staple food, sweetmeats are much indulged in. In 71 skulls ten cases of caries, in three of which six teeth were involved.

The Natives of Northern India. Diet—vegetables of a simple and wholesome character, staple food being wheat. In 152 skulls nine cases of caries, and in no instance more than two teeth affected.

In an examination carried out by S. Colyer of 261 successive recruits for the mines of the Congo (ages 15 to 65) 96·9 per cent. were free from caries. Calculating twenty-eight teeth to each individual there was one carious tooth in 270. These recruits came from the tribes of Central Africa, whose diet is mainly grain and ground vegetables and beans.

An interesting report on the examination of old human crania deposited in the principal museums of the United States is published in the *Transactions of the American Dental Association*, 1894, and is well worthy of perusal by those wishing to investigate the subject.[1]

(3) Modern Civilized Races

Among modern civilized races the percentage of mouths containing carious teeth has increased to an alarming extent. The

[1] The following is a *résumé* of the results obtained:—

Total number of teeth examined	46,657
,, ,, ,, diseased	11,338
Percentage of diseased teeth	24·3

The crania were grouped geographically as follows:—

Country	Number of teeth examined	Number of teeth diseased	Percentage of diseased teeth
South America	6,719	2,462	36·6
Central America	930	250	26·8
North America	27,362	5,811	21·2
Europe (including Anglo-Americans)	3,422	1,373	40·4
Pacific and Sandwich Islands ...	2,738	417	15·25
Egypt	3,306	689	20·8
Asia	2,180	336	15·4

collective investigations of the British Dental Association showed that out of 10,500 English and Scotch girls and boys, averaging 12 years of age, there were no less than 37,000 unsound teeth (deciduous and permanent). In all, 86 per cent. of the mouths showed that caries was present in one form or another.

The subjoined table[1] shows the relative ratio per hundred of children with unsound teeth, defective deciduous teeth, and defective permanent teeth. The figures afford an illustration of the early age at which the decay begins, and also of the progressive increase of the disease as children grow older.

Age period	iv.-vi.	vii.-ix.	x.-xii.	xiii.-xv.	xvi.-xviii.
Number examined	744	1,716	3,071	2,376	268
Sound (no decay)	23·8	14·2	16·1	14·1	6·4
Defective temporary teeth only	67·4	43·3	18·3	5·1	0·1
Defective permanent teeth—					
1—4	8·8	41·5	55·9	51·9	37·3
5—8	—	1·9	8·5	22·9	32·6
9 or more	—	—	1·2	6·0	23·6
	100	100	100	100	100

Another illustration of the ravages of caries can be gathered from the statistics compiled from the examination of the children in the County of Shropshire.[2] It was found:—

(1) That only 3 per cent. of the children at the age of twelve and only 5 per cent. at the age of five were free from caries.

(2) That the average number of carious teeth at the age of five was 6·8 and at the age of twelve was 4·8.

(3) That out of 3,794 children examined at the age of five, no less than 1,017 had ten or more carious teeth; and out of 3,580 children at the age of twelve, 876 had seven or more carious teeth.

The foregoing figures relate to children attending the Poor Law schools, workhouses, and reformatories. Equally unsatisfactory conditions have been shown to exist among children in better circumstances; for example, 560 boys, average age 13 years 7 months, belonging to one of our large public schools, had lost 701 of the permanent teeth, while 3,521 were carious. In the mouths of 87 per cent. of the boys caries was present. In America,

[1] Memorandum in regard to the condition of the teeth of school children. Published by the British Dental Association, p. 64, showing the relative ratio per hundred children having unsound teeth, defective temporary teeth, and defective permanent teeth.

[2] The Seventh Annual Report of the School Medical Officer of the Salop County Council, 1914.

Germany, Hungary, and other countries, similar investigations have yielded much the same results. The investigations of Unghvari (Hungary) and Berten (Wurzberg) show the percentages of carious teeth to be 87·2 and 83; while Röse, in an extended inquiry in Baden and Thuringia, and Fenchel (Hamburg) showed caries present in 98·75 per cent. and 96·4 per cent., respectively. The statistics of the latter observers tend to show that, as regards caries, the teeth of English children compare favourably with those of German children.[1]

The foregoing figures will suffice to illustrate the appalling ravages of dental caries among modern races. It is satisfactory to know that other investigations have brought forth results which show more hopeful conditions. For example, C. M. Cunningham[2] found that among fifty-four children in the Arran Islands there were thirty-three perfect dentures, and clinical experience undoubtedly shows that the number of perfect dentures is increasing among the children of the more intelligent sections of the community.

Caries in Animals.—In the horse, caries is by no means a rare disease, and in an examination of 484 skulls caries was met with in 66.[3] In some cases the condition was slight, whilst in others

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[1] The following communications on this subject are of interest:—

The various reports of the School Children's Committee appointed by the British Dental Association.

Voerckel and Weber. "On the Care of the Teeth of Children in the National Schools of Elberfeld and Witten," *Deutsche Monatsschrift für Zahnheilkunde*, translated in Ash's *Quarterly Circular*, December, 1899, and March, 1900.

Röse. "On the Decay of Teeth in the National Schools of Germany," *Oesterreich-Ungarische Vierteljahrsschrift für Zahnheilkunde*, translated in Ash's *Quarterly Circular*, March and June, 1895.

Unghvari. *Oesterreich-Ungarische Vierteljahrsschrift für Zahnheilkunde*, translated in Ash's *Quarterly Circular*, September, 1896, p. 353.

Berten. *Aus den Sitzungsberichten der Würzburger physik. med. Gesellschaft*, 1894, xv, Sitzung, November 17.

Fenchel. "Die Caries Frequenz Hamburger Schulkinder," *Correspondenz-Blatt für Zahnärzte*, October, 1893.

Ottofy. Addendum in Parreidt's "Compendium of Dentistry," Chicago, 1889, p. 57.

Cunningham, C. M. "An Examination of Teeth in the Arran Islands, co. Galway," *Journ. Brit. Dent. Assoc.*, vol. xviii, p. 652.

[2] "An Examination of Teeth in the Arran Islands, co. Galway," *Journ. Brit. Dent. Assoc.*, vol. xxiii, p. 652.

[3] "Variations and Diseases of the Teeth of Horses," J. F. Colyer, *Trans. Odonto. Soc.*, vol. xxxviii, p. 42.

extensive destruction of the teeth had occurred (see fig. 449). Owing to the arrangement of the dental tissues, the carious tissue

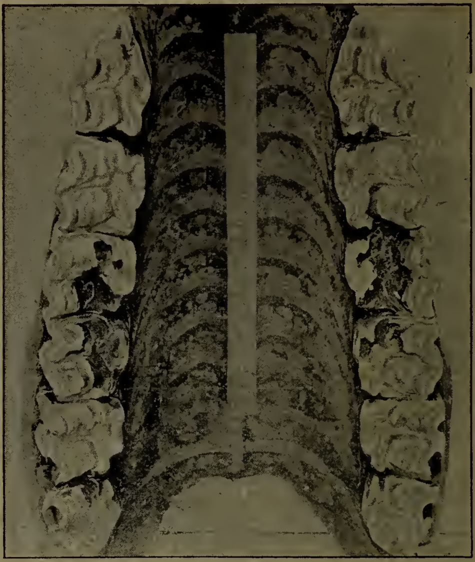

FIG. 449.[1]—Maxillæ of a horse showing extensive caries of the teeth.

FIG. 450.—Skull of a dog showing caries on the labial aspects of the teeth.

is removed in a great measure in the process of mastication, so that more or less cup-shaped depressions, lined with a thin layer of

[1] From *Trans. Odonto. Soc.*

softened tooth tissue, are formed. Caries is also met with in the dog (fig. 450) and in certain animals in captivity, such as the monkey and rodents.

Caries is rare in animals in the wild state with the exception of monkeys. Among these animals the genus Cebus seems especially liable to be attacked, for in 137 specimens examined eleven showed caries, and in three cases the disease was extensive.

(B) FREQUENCY IN INDIVIDUAL TEETH

The various groups of teeth in human beings are subject to caries in different degrees. The statistics bearing on this question are nearly all derived from records of extractions and it is needless to say that statistics so obtained will not correctly represent the relative tendency to caries in the different groups. The first permanent molars are more subject to caries than other teeth, and the mandibular more than the maxillary. These teeth are erupted early and the liability to caries is due to the unhygienic conditions in the mouth at this period rather than to any inherent structural defect. The caries nearly always commences on the occluding surfaces. These teeth are probably less liable to decay on the approximal surfaces than the maxillary premolars. The second molars probably follow next to the first molars in their liability to caries, the mandibular being attacked more frequently than the maxillary. It is extremely difficult, without trustworthy statistics, to place the incisors and premolars correctly as regards their liability to caries. Experience affords little evidence on which to choose between the first and second maxillary premolars in this respect, but with regard to the mandibular premolars the liability to caries is more marked in the second than in the first. The mandibular incisors are comparatively immune to caries, and this is due as much to their shape as to the constant mechanical cleansing action of the tongue and lips. The liability of the third molars to caries in mouths where all the teeth are present is attributable to difficulty in keeping them free from the lodgment of food débris.

Frequency in Relation to Sex and Age.—It is generally supposed that caries is more common in females than males. The observation of Röse[1] on 6,280 children, boys and girls being about equally divided, showed the percentage of caries in boys to be 26 and girls

[1] Röse: "On the Decay of Teeth in the National Schools of Germany," *Oesterreich-Ungarische Vierteljahrsschrift für Zahnheilkunde,* translated in Ash's *Quarterly Circular,* March and June, 1895.

26·2. Caries is more active during the period of growth of the individual than subsequently. A fresh period of activity often appears with conditions which lead to exposure of the roots of the teeth, the caries commencing in the cementum.

(C) MORBID ANATOMY AND PATHOLOGY

(1) MACROSCOPICAL APPEARANCES

(*a*) **Enamel.**—In the enamel, the naked-eye appearances of caries can best be observed upon the approximal side of a molar or premolar. The first indication of the presence of caries is that the enamel loses its normal polish and translucency. Next, a whitish spot appears which gradually becomes darker. When the process is slow, the discoloration is more marked than when the process is rapid. As the enamel prisms become disorganized, they are mechanically washed away and a cavity is left which varies somewhat in form, being sometimes broad and shallow with indis-

× 35.

FIG. 451.[1]—Decalcification of the enamel without loss of substance (Miller).

[1] From *Dental Cosmos*.

tinguishable margins, at other times deep with sharp, rugged margins. The destruction advances until the dentine is reached.

At times decalcification may have attacked the dentine before any disintegration of the enamel has occurred (see fig. 451).

When caries commences on the approximal aspects of the teeth, the actual point of contact is not always decalcified, but around it is a zone showing decalcification. This zone corresponds to the area on the tooth where fluid would be held by capillary attraction.

× 25.

Fig. 452.[1]—Primary and secondary caries of enamel, showing marked difference in their character (Miller).

When the decay which has started on an approximal surface reaches the under surface of the enamel of the crown (as is frequently the case in molars and premolars), the enamel at that part appears bluish-white and translucent, especially by artificial light. This appearance is produced by the decalcified tissue which has not been removed by the saliva. As the caries reaches the surface, the enamel grows whiter, and eventually becomes so thin that mastication fractures it, and the under surface is found to be

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[1] From *Dental Cosmos.*

of a soft, cheesy consistency. Caries commencing on the dentinal aspect of the enamel and proceeding to the surface is known as "secondary enamel decay" (figs. 452 and 453).

(*b*) **Dentine.**—The appearances of caries in dentine differ considerably from those in enamel. This tissue becomes of a tough cartilaginous consistence, and not soft and cheesy as with the enamel. After softening, the tissue undergoes disintegration and a cavity is formed. Pigmentation accompanies the process and,

× 10.

FIG. 453.[1]—Secondary caries of enamel. The acid destroys the enamel as it advances. Apparent increased transparency of the enamel (Miller).

as in caries of the enamel, the discoloration depends to a great extent upon the rate of progress of the disease.

Caries may spread in any direction and with varying degrees of rapidity. The rapidity of its progress depends upon the intensity of action of the various ferments. The direction taken is largely determined by the structure of the tooth. In a tooth of ordinary structure the cavity formed is somewhat cone-shaped, the apex of the cone being towards the pulp. In badly developed teeth with a large number of interglobular spaces, the decay will extend

[1] From *Dental Cosmos.*

laterally and considerably undermine the enamel, whilst in teeth where the dentine is well calcified the decay will extend more in the direction of the pulp than laterally, giving rise to what is known as "penetrating caries."

In hypoplastic teeth the caries often extends rapidly near the junction of the enamel with the dentine and causes the enamel to break away, producing an appearance as illustrated in fig. 454.

In "rapid caries" the dentine can be removed in large leathery masses, the action of the acid being more rapid than that of the peptonizing organisms. This condition is called **"caries humida."** When the carious process is slow, the action of the peptonizing organisms almost keeps pace with the action of the acids.

(*c*) **Cementum.**—Caries of the cementum is less common than caries of the dentine or of the enamel. It generally starts at the neck of the tooth, though it may attack any part of the root when the roots are exposed through loss of the periodontal membrane.

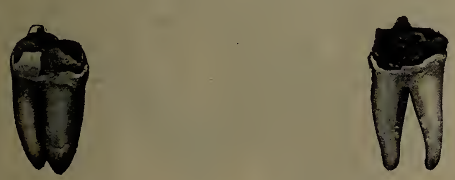

Fig. 454.

The cemental tissue first becomes softened, and disintegration follows, leading to the formation of shallow cavities. The cavities become widely extended, but owing to there being no circumscribed points of retention, they are seldom deep. An exception, however, occurs at the angle formed by two roots of a molar, the cavity at these points often becoming deep.

(*d*) **Enamel Cuticle.**—The naked-eye appearance of decay of the enamel cuticle is a more or less pronounced discoloration.

(*e*) **Phenomena accompanying caries:**—

(i) Translucency.

(ii) Pigmentation of the disintegrated parts.

(i) Translucency.—If the dentine of a tooth in which caries is in progress be examined, it will be found that in the part situated between the pulp and the caries the tissue appears translucent (fig. 455). The translucent zone is best observed in those teeth in which the enamel only is attacked and the dentine is perfectly sound. The affected area assumes the shape of a cone with its apex towards the pulp and on either side of this area two opaque lines will usually be seen.

There is a difference of opinion as to the cause of this translucency. The opacity of normal dentine is due to the fact that the matrix and the contents of the tubes have different refractive indices. If these indices are approximated the dentine becomes translucent. The difference in the refractive indices would be removed (1) if the matrix were transformed so as to resemble the contents, i.e., by *decalcification of the matrix;* (2) if the tubes became filled with materials resembling the matrix, i.e., by *calcification of the tube contents.*

× 10.

FIG. 455.[1]—Section of molar showing typical translucent zone in the dentine (Miller).

The following facts support the view that the translucency is due to a change in the contents of the tubes:—

(*a*) Injury of the dentinal fibrils causes reaction in the pulp, leading to the formation of adventitious dentine at the point corresponding to the commencement of such fibrils on the surface of the pulp.

(*b*) The diameter of the tubes, according to Walkhoff and Baume, is distinctly lessened in the translucent zone.

(*c*) Chemical analyses of the dentine forming the translucent zone have been carried out by Miller and Jeserich. The former

[1] From *Dental Cosmos.*

found 71·9 per cent. ash from translucent zone dentine and 72·1 per cent. from the normal dentine of the same teeth, a difference which is quite likely to be due to an error of experiment. Dr. Jeserich's results gave 68 per cent. for the normal and 69·5 per cent. for the translucent dentine. The experiments, therefore, do not point to decalcification as the cause of translucency.

(*d*) Stains do not readily affect the translucent zone. Partially decalcified dentine is readily stained with eosin, but the stain has little effect on the translucent zone.

(*e*) Charters White has found that in specimens in which the dentinal tubes are permeated with coloured collodion, the tubes in the translucent zone are only slightly permeable.

(*f*) If the translucent zone were the result of decalcification we should expect to find it in all sides of the carious cavity, but this is not the case, the only portion of the dentine affected being that containing fibrils which have been injured by the carious process.

(*g*) In artificial caries there is no translucent zone.

(*h*) In caries progressing in pulpless teeth there is no translucent zone. Miller examined sixty teeth which had been worn in the mouth on plates. Most of the teeth showed various stages of decay, but translucency was only present in one, and even in that one it was impossible to say that the translucency had not originated when the pulp was alive.

The theory that translucency is due to decalcification of the matrix is based mainly on the assertion of certain observers that the translucent zone is present in teeth used as artificial substitutes.

F. J. Bennett[1] states that in some specimens he has noticed the tubes thickened and enlarged in the translucent zone. He is of opinion that in a specimen of a maxillary central incisor which had been mounted on a plate and afterwards affected by caries he found a translucent zone. It would, however, be exceedingly difficult to prove that the translucency was not present in this tooth prior to its use as a substitute.

(ii) Pigmentation.—The pigmentation accompanying caries varies from a pale yellow to a black; the more acute the process, as a rule, the lighter the colour. As the discoloration in carious teeth is produced solely by outside agency and is also seen in dentine free from caries it may be safely assumed that it is merely an incidental phenomenon of the disease and not an active agent in producing the disease. The discoloration is in all probability produced by the action of chromogenic bacteria.

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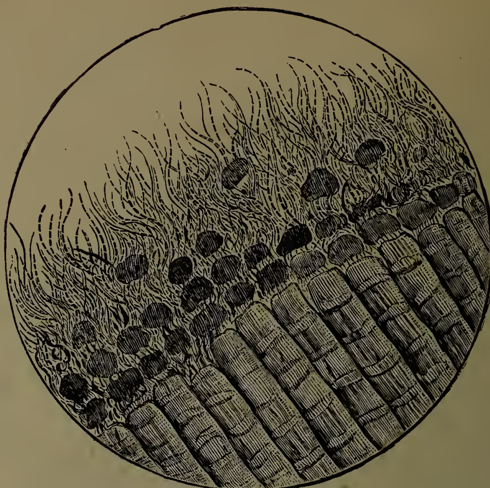
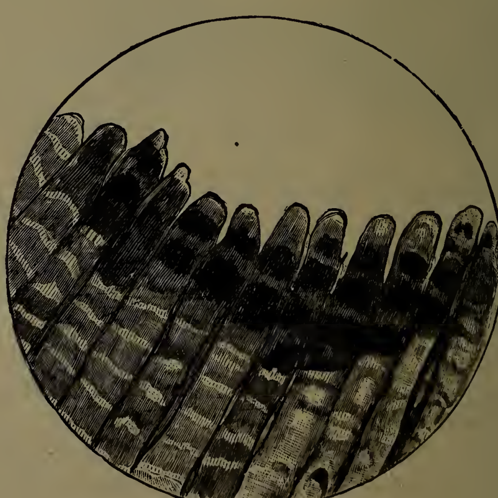
[1] *Trans. Odonto. Soc.*, vol. xxvii, 1895, p. 155.



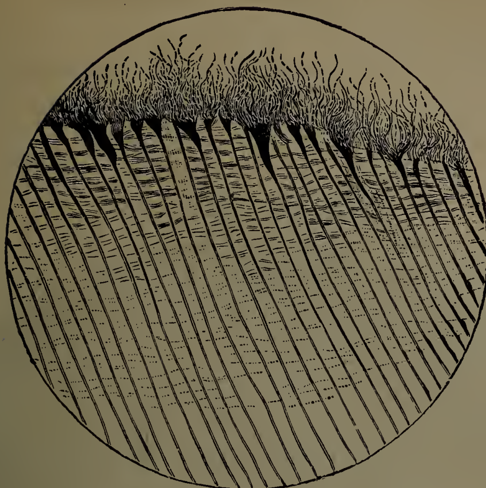
× 1,500.

Fig. 456.—The *modus operandi* of the process of caries, according to Leon Williams, varies somewhat, in different specimens. In this specimen, the sectional masses of the enamel rods are being set free by the solution of the cement substance which unites them.



× 1,500.

Fig. 457.—The felt-like mass of micro-organisms has been removed to show the action of the acids on the ends of the enamel rods at the decaying surface.



× 800.

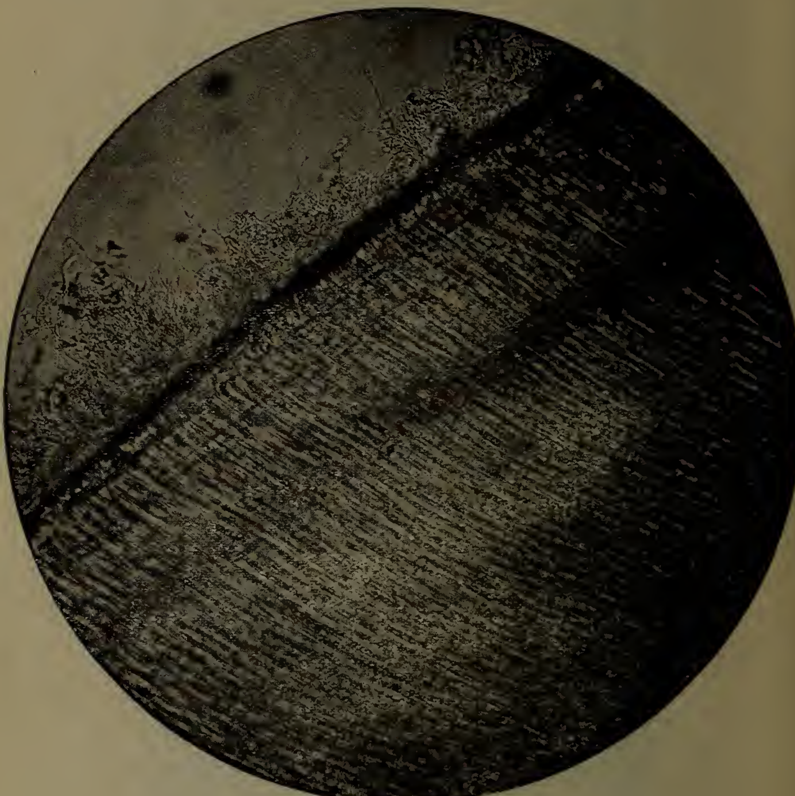
Fig. 458.—Showing commencement of the carious process. The felt-like mass of micro-organisms is seen attached to the surface. The cone-shaped cavities between the enamel prisms, produced by solution of the cement substance between the enamel rods, are also shown.

× 800.

Fig. 459.—Showing the commencement of the formation of a carious cavity in the enamel. The cavity is seen to be lined with the felt-like mass of micro-organisms similar to those seen on the surface of the enamel at the commencement of decay.

(2) CHEMICAL CHANGES

The chemical changes which take place in carious teeth consist in a decrease in the amount of lime salts, with loss also of organic matter. In analyses undertaken by Miller it was found that carious dentine contained only about one-thirteenth of its original amount of lime salts while the organic material was also reduced by two-fifths.



× 300.

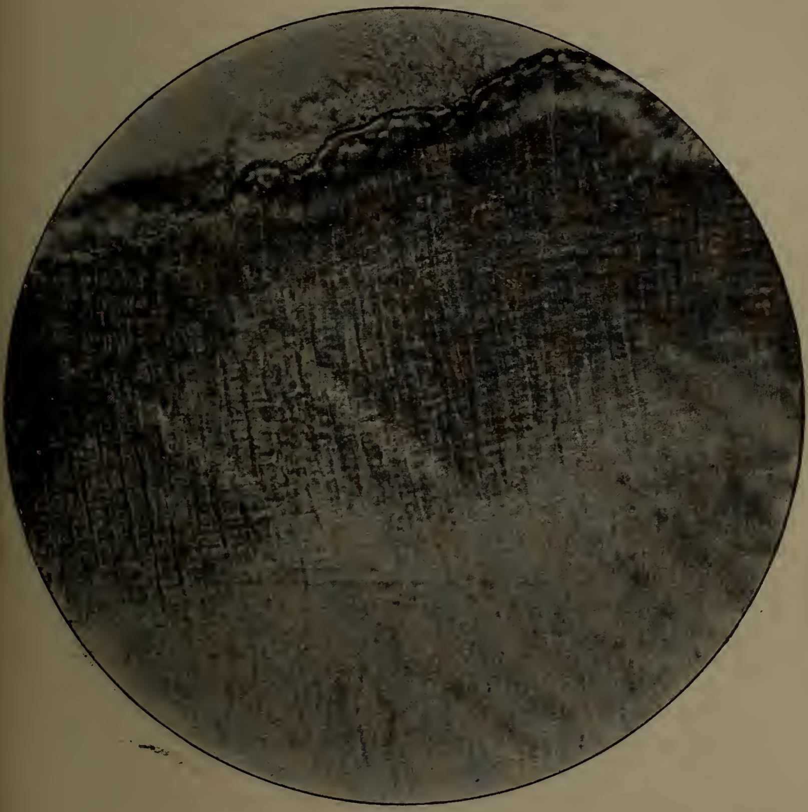
Fig. 460.—Section showing felt-like mass of micro-organisms attached to surface of enamel. Photomicrograph by Leon Williams.

(3) MICROSCOPICAL APPEARANCES

(*a*) **Enamel.**—For microscopical examination, thin sections must be prepared by grinding and stained to show the micro-organisms.

Sections of carious enamel (fig. 460), according to Leon Williams and others, show the surface to be covered with a felt-like mass of

micro-organisms. The enamel is decalcified between the rods and the interstitial cement substance, the enamel globules thus unbound being either dissolved or washed away. The enamel may be penetrated to a considerable depth before any breaking down of the tissue occurs.

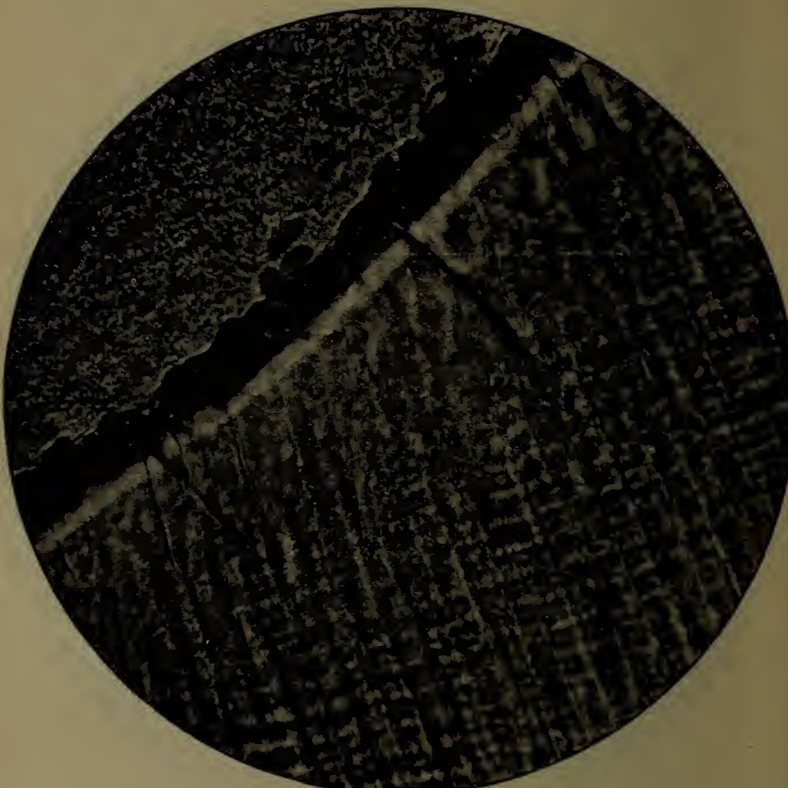


× 800.

FIG. 461.—Showing commencement of caries. Enamel rods separated by solution of cement substance and discoloured by action of acid. From a photomicrograph by Leon Williams.

An interesting contribution to the study of caries of the enamel was published by Leon Williams in the *Dental Cosmos*, March, 1897, *et seq.*

The various stages of caries of the enamel are shown in figs. 456 to 466.

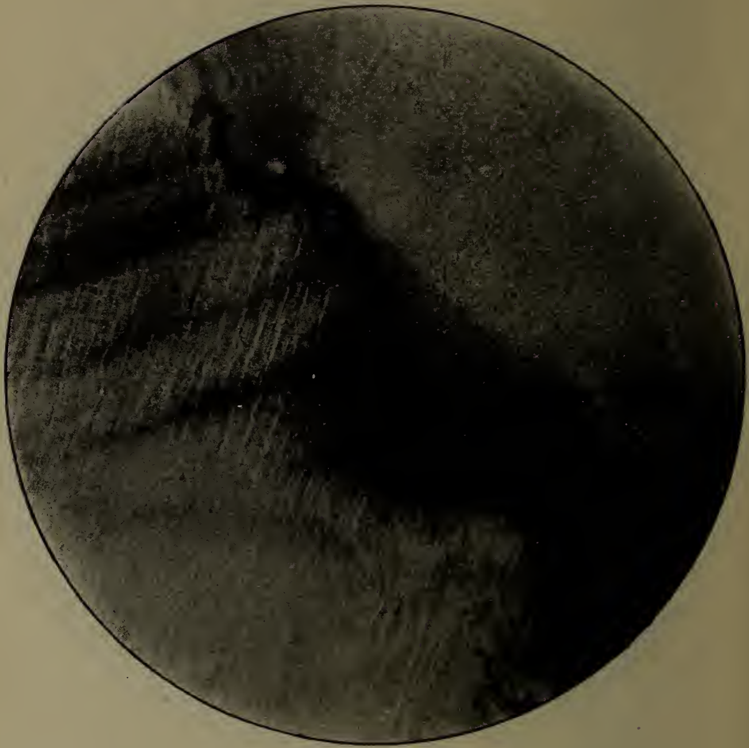


× 1,200.

Fig. 462.—Section of carious enamel, showing destruction of tissue by solution of cement substance around enamel rods and globular bodies. From a photomicrograph by Leon Williams.

× 300.

Fig. 463.—Section showing progress of slow decay marked by deep discoloration of the tissue. The felt-like mass of micro-organisms on the surface is also seen. From a photomicrograph by Leon Williams.



× 800.

Fig. 464.—Similar to the section shown in fig. 463, but under a much higher power. At the upper left-hand corner, the ends of the enamel rods are seen projecting, showing that the cement substance is first acted on by the acid of decay. From a photomicrograph by Leon Williams.

The four diagrams figs. 456 to 459 are from drawings by Leon Williams.

The five figures 460 to 464 are from sections of carious enamel prepared by Leon Williams.[1]

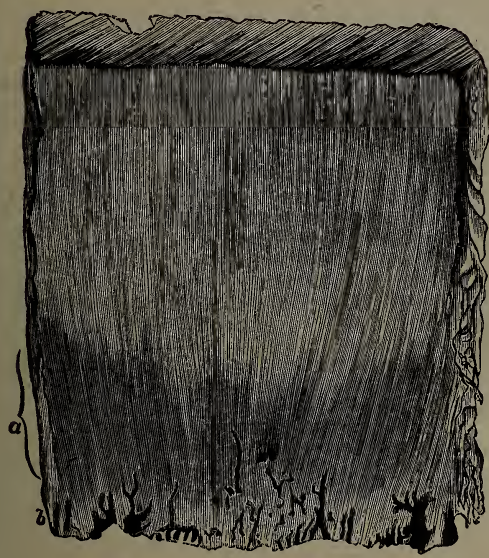


Fig. 465.—Secondary enamel decay. (*a*) partially decalcified enamel, which has slightly taken the staining material; (*b*) zone of infected enamel, showing masses of micro-organisms working their way into the decalcifying zone (Miller).

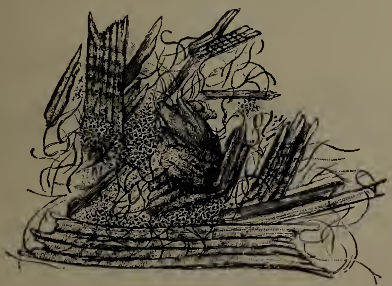


Fig. 466.—Disruption of prisms in secondary enamel decay (Miller).

In several of the preceding figures a felt-like mass of micro-organisms is seen adhering to the surface of the enamel. Leon

[1] I am indebted to Dr. Leon Williams for the use of the blocks of figs. 456 to 459, and also for the photomicrographs reproducd in figs. 460 to 464.

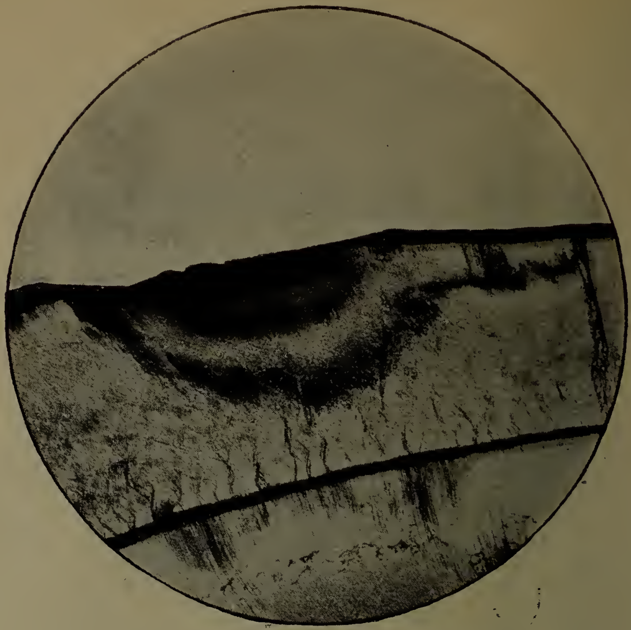


Fig. 467.—Extensive caries without bacterial plaque (Miller). From *Dental Cosmos.*

Fig. 468.—Extensive bacterial plaque without a trace of caries (Miller). From *Dental Cosmos.*

Williams and G. V. Black attach considerable significance to these "bacterial plaques." These "plaques" are not a necessary accompaniment of the carious process, and they can, moreover, be demonstrated in teeth without a trace of caries. (See figs. 467 and 468).

(*b*) **Dentine.**—If longitudinal sections of carious dentine which have been stained to demonstrate micro-organisms be examined microscopically, the following points will be observed.

Under a Low Power (80 mag.).—Bordering the surface (fig. 469)

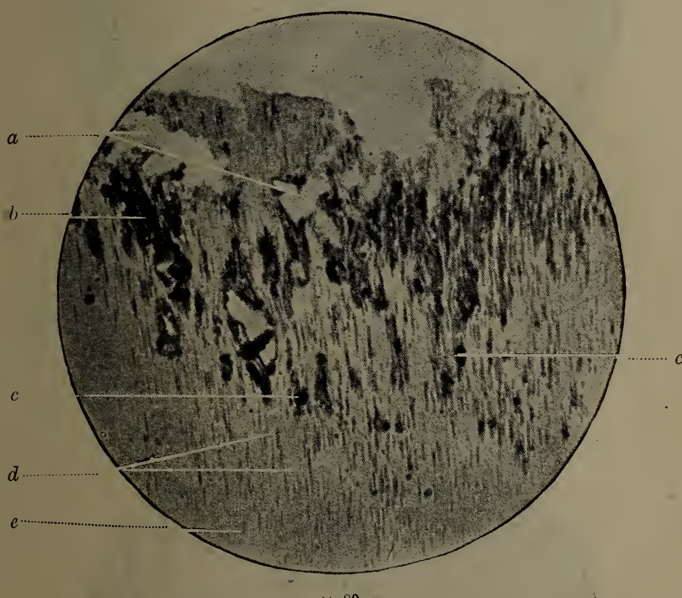


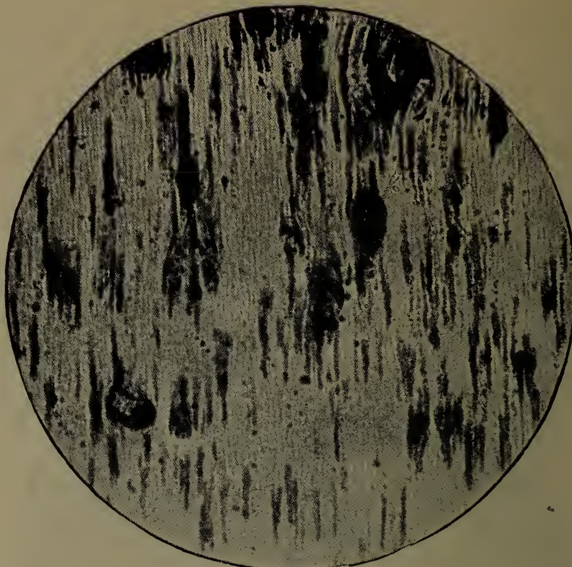
Fig. 469.—Longitudinal section of carious dentine. Photomicrograph by A. Pringle.

the dentine is hollowed out in an irregular manner, the cavities presenting no definite shape (*a*). A little deeper in the substance of the dentine irregular masses of stain can be detected (*b*), and, in places, the stain presents a globular appearance (*c*). Lower down, streaks of stain are to be seen (*d*), while still further down the dentine is unstained (*e*).

Under a Higher Power (150 mag.).—Tracing the process in the reverse order, namely, from within outwards, we notice that:—

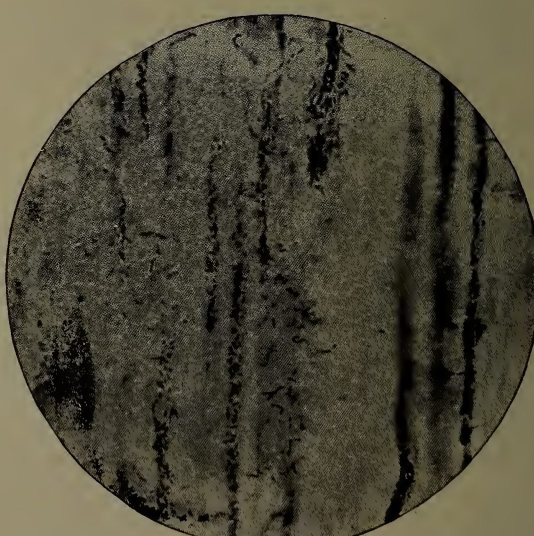
(i) The unstained part (*e*) is dentine in a decalcified condition.

(ii) The streaks of stain (*d*) are micro-organisms occupying the dentinal tubes.



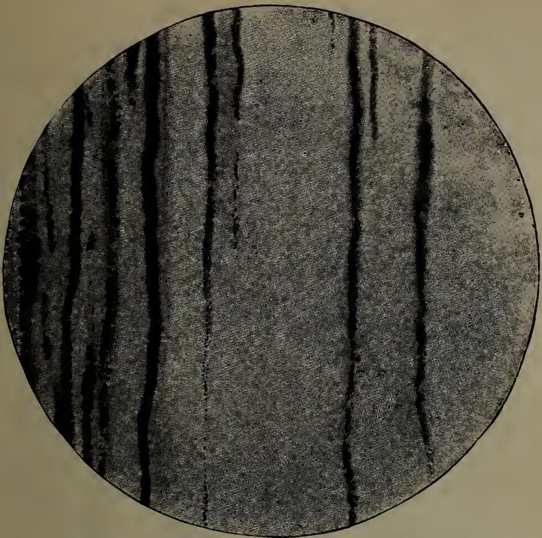
× 150.

Fig. 470.—Longitudinal section of carious dentine, showing liquefaction foci. Photomicrograph by A. Pringle.



× 650.

Fig. 471.—Longitudinal section of carious dentine, showing rod-shaped organisms in tubes. Photomicrograph by J. Howard Mummery.



× 650.

FIG. 472.—Longitudinal section of carious dentine, showing tubes filled with micrococci. Photomicrograph by J. Howard Mummery.

× 650.

FIG. 473.—Longitudinal section of carious dentine, showing tubes filled with organisms. Photomicrograph by J. Howard Mummery.

(iii) The globular masses are micro-organisms occupying the tubes and the structure between the tubes, in other words, the dentine matrix has disappeared and micro-organisms have taken its place. These globular masses have been termed "**liquefaction foci**" (fig. 470).

(iv) The irregular masses are formed by the fusion of "liquefaction foci."

In sections containing interglobular spaces, the spaces are generally seen to be filled with masses of organisms, although occasionally they appear to be quite free from infection. Figs. 471

FIG. 474.—Carious dentine, showing that, laterally, the boundary between the infected and non-infected parts may be very regular (Miller).

to 473 are longitudinal sections through carious dentine stained to demonstrate the micro-organisms.

If sections of carious dentine are stained to demonstrate the micro-organisms only, it can be shown that the softening of the dentine precedes the infection. Examine such a section and it will be seen that the softened parts towards the cavity are stained, and towards the healthy dentine unstained, which clearly shows that

the softening precedes the infection. Miller has termed the unstained portion the "**non-infected zone.**" The micro-organisms show a greater tendency to spread towards the pulp than in a lateral direction, but this is not always the case where a large number of interglobular spaces are present. The dividing line between the infected and the non-infected zones is often well marked (fig. 474), and though the majority of tubes near the surface are infected, the infection is not noticeable in the deeper parts. Near the margin, leptothrix is mainly found, while the tubes are generally filled with micrococci or simple bacilli.

Fig. 475.—Row of shining granules in the tubules from a tooth used as an artificial substitute (Miller).

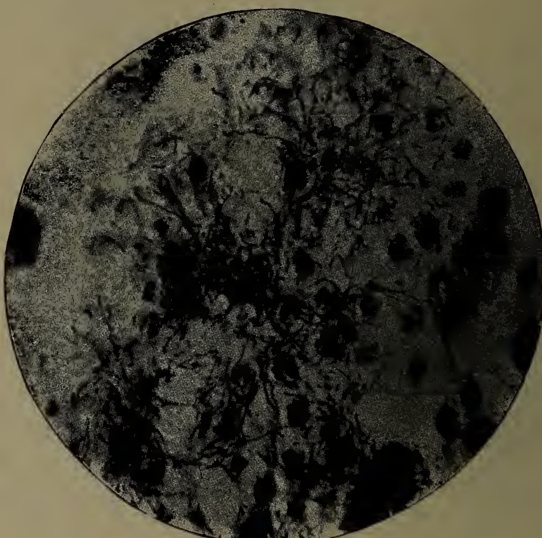
The Infection is often of a Mixed Character.—Micrococci and bacilli are usually present and generally in separate tubules, but a single tubule may contain a mixed infection.

In addition to micro-organisms, *rod-shaped fragments or elements can usually be demonstrated in the tubules* and are also seen in artificially produced caries. These elements, the source of which is not definitely known, are conjectured to be either (i) portions of consolidated fibrils; (ii) pieces of the sheaths of Neumann; or (iii) casts of the enlarged fibrils. Miller finds that these elements disappear immediately they are brought into contact with inorganic acids (dilute sulphuric acid), but become more distinct when organic acids are used, and he therefore thinks it probable that they are lime formations. *Rows of shining irregular granules* are also met with generally in the area in advance of the caries (fig. 475). It is

possible that these granules have the same origin as the rod-shaped elements, for, if the latter be crushed, granules can be produced.

Transverse sections near the carious cavity show the tubes enlarged and filled with micro-organisms (fig. 476). In transverse sections taken nearer to the normal dentine, it is found that the sheath of the dentinal tubes is considerably enlarged, owing, probably, to decalcification. The appearance of the dentine in this condition has been termed the *tobacco-pipe* appearance (Tomes). This is shown in fig. 477.

The tobacco-pipe appearance is also seen in caries occurring in teeth used as substitutes, and in caries produced by artificial means.



× 650.

Fig. 476.—Transverse section of carious dentine, showing enlarged tubes filled with micro-organisms.

In the *Trans. Odonto. Soc.*, vol. xxiv, p. 90, C. S. Tomes has figured a tooth found in the graveyard of an old church. The cementum and dentine of this tooth have been bored in many directions by a fungus, probably the *Saccharomyces mycoderma* (Miller). The penetration of the dentine by *Saccharomyces mycoderma* is, according to Miller, frequently seen in teeth used as artificial substitutes. It is not at all improbable that other fungi may possess the power of penetrating dentine.

F. J. Bennett has recently shown some teeth from graves in

Central America, with the dentine almost completely destroyed by a fungus.

(*c*) **Cementum.**—Caries of cementum (fig. 478) resembles caries of dentine in some details, especially when the micro-organisms penetrate, as they commonly do, along the lines of Sharpey's fibres. The decalcified tissue is destroyed in precisely the same manner as in caries of the dentine.

(*d*) **The Effect of Caries on the Pulp.**—This portion of the subject is dealt with in detail in a later chapter treating of the pathology of the dental pulp.

× 200.

Fig. 477.—Photomicrograph by A. Pringle.

(4) BACTERIOLOGY

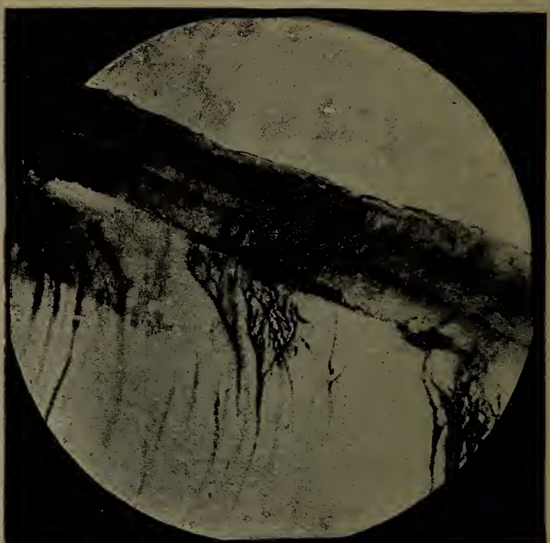
The organisms concerned in the process of dental caries have been divided by K. W. Goadby into two groups:—

(*a*) Acid-forming bacteria, or bacteria capable of producing acids by the fermentation of carbohydrates. The weak acids formed from the decomposition of proteids are incapable of attacking the lime salts of the tooth.

(*b*) Liquefying bacteria which, either by their own action or the production of proteolytic enzymes, cause digestion of the decalcified dentine.

Goadby has also shown that the numbers and varieties of

bacteria on the surface of a carious cavity are more numerous than in the deeper layers; the species on the surface of carious dentine are mostly aerobic liquefiers, many of them liquefying gelatin with great rapidity, and in addition coagulated blood-serum. Most of the organisms liquefying coagulated blood-serum will digest decalcified dentine. A small fraction are anaerobic liquefiers. The organisms from the deeper layer of caries are rarely liquefying bacteria, but nearly all of them are capable of the production of acid from carbohydrates, especially glucose, maltose, and lactose.



× 600.

Fig. 478.[1]—Caries in cementum. From a preparation by Miller. Photo-micrograph by J. Howard Mummery.

The organisms on the surface of carious dentine often possess the power of discolouring the medium upon which they are originally grown, whilst those from the deeper layers rarely possess this power.

Goadby states that not all organisms capable of liquefying nutrient gelatin also possess the power of digesting the decalcified tooth cartilage or chondrinogen. From the deeper layer of the carious dentine he has frequently isolated an organism for which he suggests the name *Bacillus necrodentalis*, and he seems to think that this organism may stand in some causal relationship to caries,

[1] From *Journ. Brit. Dent. Assoc.*

inasmuch as its characteristics fit in with the process of decay. In sixteen out of twenty cases he obtained the *S. brevis*, and as this organism and the *B. necrodentalis* are facultative anaerobics and are both acid producers, he considers that they may be largely instrumental in decalcifying the matrix prior to its disintegration by other organisms.

Another organism, hitherto unrecognized in the mouth, has been found by Goadby constantly associated with organisms from the surface of carious dentine, and in two out of twenty cases with organisms from the deeper layers. This organism, he considers, belongs to the *Streptothricæ*, and has been termed by him the *Streptothrix buccalis*. The following is a list of the bacteria of dental caries as given by Goadby:—

Acid-forming Bacteria.

Streptococcus brevis *B. necrodentalis* (Goadby) *S. albus*	Deep layers of carious dentine.
S. brevis *Sarcina lutea* ,, *aurantiaca* ,, *alba* (Eisenberg) *S. albus* *S. aureus*	Superficial layers of carious dentine.

Bacteria which liquefy Dentine (decalcified).

None isolated as yet.	Deep layers of carious dentine.
Bacillus mesentericus ruber (*vulgatus*), Gisen. *B. mesentericus vulgatus.* *B. mesentericus fuscus.* *B. septus* (*B. furvus*). *B. liquefaciens fluorescens.* *B. subtilis.* *Proteus zenkeri.* *B. plexiformis* (Goadby) *B. maximus buccalis* (Goadby)	Superficial layers of carious dentine.

A careful study of the Micro-organisms of Dental Caries has been published by Howe.[1] The investigation was carried out as follows:—

(1) Fillings were inserted over the carious mass, care being taken not to injure the flora in any way; by this means it was

[1] *Dental Cosmos*, October, 1917.

hoped that the extraneous flora would die, while the flora that was most resistant in this environment would live. After a period of from six weeks to three months the fillings were removed and the underlying carious dentine was examined.

(2) Fillings having slight antiseptic properties were placed over the carious dentine, but left for a much shorter period. This was done in the hope that the bacteria readily affected by the antiseptic would give way to the more sturdy and vigorous flora intimately associated with caries.

(3) The carious dentine in the open cavity was examined. In all cases the carious dentine was removed in three layers (*a*) superficial; (*b*) middle; (*c*) deep—layer (*c*) included dentine apparently unaffected. Cultures were made from each stratum in agar, glucose-agar, bouillon, and blood-serum. It was found that the only constant flora present belonged to the Moro-Tissier group of organisms, and nothing else was present in the cavities that had had the extraneous flora excluded by fillings, and nothing else was present in 38 per cent. of the open cavities.

These researches are of interest, but they do not demonstrate that the Moro-Tissier group is the organism responsible for the fermentation of the carbohydrates.

The foregoing particulars relating to the bacteriology of caries show that as yet nothing is definitely known as to the exact relation of the various organisms to the carious process. Research might with advantage be made in the direction of producing artificial caries with the various types.

(5) THE SOURCE OF THE ACID

The **principal acid formed is lactic,** from amylaceous and saccharine substances, which find a lodgment on the tooth, and undergo fermentation. In the case of sugars, those belonging to the grape-sugar group, namely, dextrose, levulose, galactose, and maltose, are directly fermentable according to the equation

$$C_6H_{12}O_6 = 2C_3H_6O_3$$

Cane-sugar and milk sugar are only fermentable after hydrarization—

$$\underset{\text{(Cane-sugar)}}{C_{12}H_{22}O_{11}} + H_2O = \underset{\text{(Dextrose)}}{C_6H_{12}O_6} + \underset{\text{(Levulose)}}{C_6H_{12}O_6}$$

The dextrose and levulose are then acted on by the lactic acid ferment.

In the case of starch, the ptyalin transforms the starch into grape-sugar, which is then directly fermentable.

Experiments have proved that, when fermentable albuminous materials are combined with saliva, little acid is formed, which soon disappears; while, when the putrefaction of albuminous substances, such as meat, takes place in the mouth, acids are formed, but they are more than neutralized by the various alkaline products which appear, so that the reaction of the medium is distinctly alkaline. Vegetable food is less likely to ferment when raw than when cooked.

When once decalcification by means of the acids has taken place, the remaining organic portion of the tooth substance is dissolved by the action of bacteria which perform their work by acting upon the dentine in much the same way as the pepsin of the gastric juice acts upon albuminous materials. The view that the acid is formed directly from the fermentation of food is not held by all observers.

The following table, suggested by Howard Mummery and the late Dr. Miller, shows the part that the different classes of foodstuffs play in the production of caries.

FOODSTUFFS

- **Proteids (nitrogenous foods)** — Their decomposition by bacteria gives rise to a large number of different products resulting in an alkaline reaction.
- **Carbohydrates**
  - **Cellulose** — The action of bacteria on this substance in the mouth (probably but slight) has not been determined.
  - **Starch** — Acted upon by ptyalin produces — Dextrose or maltose; Dextrine[1] — Acted upon by bacteria produces — Lactic acid (and traces of other acids).
  - **Sugar**
    - **Fermentable** — Acted upon by bacteria produces — Lactic acid (and traces of other acids).
    - **Non-fermentable** — Converted into fermentable sugar by a hydrolytic ferment contained in many bacteria, *e.g.*, $C_{12}H_{22}O_{11} + H_2O$ (Cane-sugar) $= C_6H_{12}O_6 + C_6H_{12}O_6$ (Dextrose) (Levulose) — Acted upon by bacteria produces — Lactic acid (and traces of other acids).
- **Fats** — ? Fermentation in the mouth may result in traces of fatty acids, but so far undetected.

[1] Regarding the action of mouth bacteria on dextrine very little is known.

Miller[1] and, indeed, the vast majority of writers believe that the acid is formed from solid food. It seems doubtful, however, whether, in forming this opinion they have attached sufficient importance to the fermentation of food in a fluid state.

It has been shown that the *primary decalcification of the enamel often starts around, and not at, the point of contact.*[2] This fact would seem to indicate that in such cases the food is in a fluid condition, and is maintained around the point of contact by capillary attraction. Again, in mouths kept absolutely free from solid food, caries is often found progressing in pits, fissures, &c., which clearly shows that the disease must arise from the action of fluids, and not solids.

Solid food cannot ferment at the same rapid rate as liquid food, and, moreover, with solid food a certain degree of solution is necessary in order that the organisms may produce any appreciable change. The reason for the slower fermentation of solid or pulpy substances is that the particles cannot move so freely about as they can in a fluid. In solid substances, the acid formed by the microbe in its immediate neighbourhood cannot disperse, and consequently when the acid has been raised to a certain percentage the action of the organism is inhibited. A full recognition of the fact that food in a fluid state ferments more rapidly than in a solid condition, will help to clear the way to an understanding of the etiology of the disease.

In the section describing the microscopical phenomena of carious enamel, it was pointed out that a felt-like mass of micro-organisms was constantly present on the surface of the tooth. Leon Williams says: "This mass of fungi is so dense and adhesive as to make it highly improbable that the enamel is affected, except in rare or special instances, by any acid other than that which is being excreted by the bacteria at the very point where they are attached to the enamel." This felt-like mass, however, is present in enamel not undergoing caries, and is at times absent in cases where caries is active, facts which do not support the theory advanced by Williams.

A. Lohmann[3] considers that the mucin is the agent which brings about the decalcification of the enamel, the mucin being set free from its combination with salts by the action of some acid. He

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1 "Micro-organisms of the Human Mouth," p. 205.

2 See "The Problem of Dental Caries," S. Colyer, *Dental Record*, vol. xxiv, p. 301.

3 *Archiv für Zahnheilkunde*, June, 1904.

states that: "On account of the short stay of carbohydrates in the mouth, but a very slight transformation of the same can take place, whereby only maltose is formed. The production of lactic acid, however, presupposes the formation of grape-sugar, since cane-sugar undergoes no changes whatever in the saliva. Consequently, lactic acid cannot be formed in the mouth." This question was fully dealt with by Miller,[1] who considers that, theoretically, logically and experimentally the hypothesis of Lohmann is not in accordance with known facts.

Clinically, there is evidence to show that mucus is causally related to caries. Children who, in consequence of being mouth-breathers, have developed a marginal gingivitis around the anterior teeth, show a marked tendency to caries on the approximal and labial aspects of the anterior teeth, and this tendency exists even in mouths where every care is taken to cleanse the teeth by artificial means.

Mucus secreted by the glands of the mucous membrane often has an acid reaction which is due, according to Kirk, to the presence of acid phosphates of lime and soda. It seems probable that this acid reaction is in some way related to the rapid caries of these cases, and the fact that, in mouth-breathers, the natural cleansing of the teeth is interfered with would appear to support this view.

(D) SPONTANEOUS ARREST OF CARIES

The carious process is occasionally found to have been arrested without any apparent or known cause. In such cases the teeth always show extensive loss of tissue, the enamel of the masticating surface, and often of the sides, having disappeared. The exposed dentine is darkly stained and, to the eye, presents a polished appearance. Probing will show that the dentine is hard, possibly harder than in the normal condition. The appearance of the teeth indicates that the carious process, during activity, was general and rapid in character. Spontaneous arrest of caries may occur either in deciduous or in permanent teeth, but only in those with living pulps. Among permanent teeth, this condition is mostly met with in hypoplastic first permanent molars. Microscopical examination shows that the dentine retains the colour of carious dentine, or is perhaps rather darker. The surface is irregular, the dentinal tubes, which can easily be seen in the discoloured part, apparently ending abruptly on the surface.

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[1] *Dental Cosmos*, November, 1905, p. 1293.

In four sections examined, staining failed to show any micro-organism except at those spots where caries was recommencing. (See fig. 479.)

It is not clear how the arrest of the carious process is brought about. Clinical experience shows that when the normal functional activity of the mouth is restored and care is taken to prevent the lodgment of food-stuffs on the teeth, rapid caries may often be arrested. It has been suggested that the hardening of the dentine is due to dehydration, but, as the teeth are constantly bathed in moisture, it appears to be highly improbable that dehydration causes the hardening. It seems far more likely that the arrest is due to some vital activity in the tooth itself, and in favour of this view it is to be noted that the carious process is never arrested in pulpless

Fig. 479.—(*a*) Portion of dentine in which the decay has became arrested; (*b*) translucent zone; (*c*) normal dentine; (*d*) a softened patch of dentine showing micro-organisms.

teeth. Arrest of caries is met with in pulpless teeth, but the death of the pulp always occurs after the arrest of the caries.

(E) EXPERIMENTAL REPRODUCTION OF CARIES

The production of caries in teeth artificially was first successfully accomplished by Miller. Teeth which were perfectly sound, but of various degrees of density, were cut into pieces of different sizes and placed in a mixture of saliva, meat and bread. This mixture, which was repeatedly renewed, was kept for three months at 98° F., at the end of which time there was definite caries of the teeth. With caries produced by artificial means there is no translucency, but translucency probably forms no essential part of the carious process, as it is found in other pathological conditions in the mouth. If the reaction of the solution in which the teeth are placed becomes alkaline, or if the teeth are exposed to the air or

to the action of different articles of food, such as coffee, tea, tobacco, fruit, &c., shades of colour are produced similar to those found in the mouth.

M. Choquet has recorded[1] an interesting experiment in which he submitted normal dentine to the action of a pure culture of a micro-organism. From three carious teeth which had been filled he isolated five species of micro-organisms. From one of these he obtained a pure culture and applied it to a small cavity drilled in

Fig. 480.[2]—Action of acid upon bruised surface (Miller).

the incisor of a sheep, the culture being retained in position for nine months. The dentine at the end of this period was found to have undergone certain changes, namely, softening and alteration in colour. The appearances, however, were in no way typical of carious dentine and it cannot be claimed that artificial caries was produced in this experiment.

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[1] International Medical Congress, Paris, 1900, reported in *Brit. Journ Dent. Sci.*, November 15, 1900.

[2] From *Dental Cosmos.*

(F) SUSCEPTIBILITY AND IMMUNITY TO CARIES

Under this heading various questions connected with the susceptibility and immunity of individuals to caries will be considered.

The Teeth.—Abrasions, bruises, cracks and any other defects very sensibly diminish the resistance of the enamel. Deep fissures and all the defects in the enamel which furnish a lodging-place for food naturally render the tooth at these points more susceptible to caries.

Leon Williams,[1] in his paper, "The Pathology of Enamel," states that defects in structure, such as pits, grooves, fissures, pigmentations, granular and amorphous enamel, are common in the lower animals whose teeth, we know, are comparatively free from caries. But the presence of defects in the lower animals and the absence of caries is no proof that such defects do not render the teeth more susceptible to caries, when, as in the case of human beings, the necessary pabulum exists for the production of lactic acid. In the majority of the lower animals the pabulum does not exist and hence no doubt their freedom from caries. The horse may be taken as an example. In the maxillary teeth of the horse a defect is frequently found in the structure of the cemental tissue occupying the anterior and posterior "lakes." The defect takes the form of a canal which persists through the entire tooth (fig. 481), and when caries attacks the teeth of horses it invariably starts in the wall of this canal. L. A. Merillat[2] states that "the entrance of food into these pits causes more than 95 per cent. of the decayed molars of the horse." Horses kept on a diet of hay or grass are free from caries because the mouth bacteria have very slight action on cellulose material and lactic acid is not formed. When corn and other cereals are included in the diet a material is introduced from which lactic acid is formed, and the action of the lactic acid may produce caries which will start, as stated above, at the defective part of the tooth.

Opinions differ as to the part played by the structure of the tooth in relation to caries. G. V. Black[3] and C. S. Tomes[4] have shown that teeth, clinically known as soft, are not deficient in lime salts, although hitherto supposed to be deficient, and that the molars contain more inorganic material than the incisors. C. S. Tomes's figures are as follows:—

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1 "The Pathology of Enamel," *Dental Cosmos*, March, 1907.

2 "Animal Dentistry."

3 *Dental Cosmos*, 1895.

4 *Journ. Brit. Dent. Assoc.*, October, 1895.

Incisors: 71·2 per cent. inorganic salts.
,, 28·8 per cent. organic matter and combined water.
Molars: 73 per cent. inorganic salts.
,, 27 per cent. organic matter and combined water.

Black's figures, reduced to percentage of dry dentine, give 71·7 for incisors and 72·3 for molars.

Two sets of teeth were analysed by Tomes to ascertain the percentage of salts. In one set the third molars were largely

Fig. 481.[1]—In the section (A) the opening of the canal is shown, with the surrounding tissue, in the early stage of caries; the other sections show that the canals exist throughout the tooth.

affected by caries and incipient decay existed between many of the teeth, while in the other set, although much worn by attrition, the teeth were quite free from caries. The analysis gave 71·4 per cent. of salts in both cases, which is below the general average. Tomes has also shown that the dentine and also the enamel probably contain water in chemical combination with the various lime salts.

Black attaches much importance to his own investigation, and considers that "neither the density nor the percentage of lime salts, nor the strength, is in any degree a factor in predisposing the

[1] From *Trans. Odonto. Soc.*

teeth to caries or in hindering its inception or progress." The question, however, is not so much the percentage of lime salts in the teeth, but the stability of the compound which these salts form with the organic matrix of the tooth. The analyses of Black and Tomes are unfortunately in no respect qualitative and do not bring out the varying proportions of the different salts.

Experiments on the resistance of dentine to acids were carried out by Miller.[1] The results he obtained force one to the conclusion

Fig. 482.[2]—Unequal action of acid upon internal (*a*) and external (*b*) surfaces (Miller).

that there is a very great difference in the resistance which dentine from the teeth of different animals offers to the action of acids. Experiments with yellow teeth and weak bluish teeth showed "that there is a difference in the rapidity with which dentine from different teeth is acted upon by weak acid under the same conditions and that this difference will usually be found to be in favour of so-called hard dentine. The difference is not sufficiently great, however, to confer immunity upon the one tooth, while the other falls a prey

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[1] *Dental Cosmos,* September, 1903, p. 696.

[2] From *Dental Cosmos.*

to caries. It is only one of the factors, which again must not be completely lost sight of."

The main difference between teeth which are chemically known as "hard" and "soft" may be, after all, in the enamel. Some have assumed that this is improbable because the enamel contains practically no inorganic matter, but with the enamel, as with the dentine, marked differences may exist in the amount of water chemically combined with the lime salts and the proportion of the

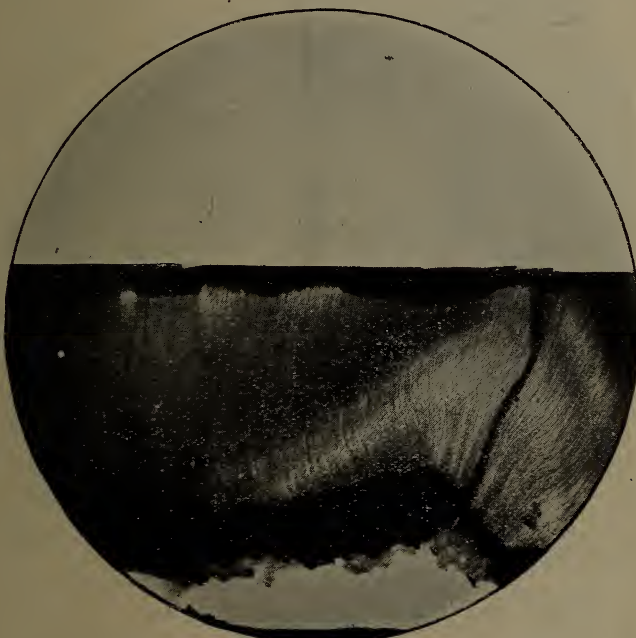

Fig. 483.[1]—Showing the influence of transparent dentine in the process of decalcification (Miller).

various salts. Until these points are determined, we certainly shall not be justified in assuming that teeth do not differ in hardness. The resistance of the enamel was investigated by Miller, and his experiments show that "the external intact smooth enamel surface offers a most stubborn resistance to the action of weak acids and far greater resistance than the internal surface" (fig. 482).

The amount of reaction which takes place in teeth with living pulps probably influences the progress of the caries. The reaction of the tooth to the carious process shows itself in the formation of

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[1] From *Dental Cosmos*.

secondary dentine and in a change in the contents of the dentinal tubes, giving rise to the "translucent zone." Experiments show that the dentine of the "translucent zone" and secondary dentine "offer a greater resistance to advancing caries than normal dentine" (figs. 483 and 484).

FIG. 484.[1]—Evident superior resistance of secondary dentine to decalcification (at *a*) (Miller).

The Influence of Lime Salts in Food.—Röse, of Freiburg, has made extended investigations as to the influence on the teeth of lime salts in food and water. His inquiries have been pursued in many countries and he has arrived at the conclusion that in districts where the soil and drinking water are rich in lime the teeth are sounder than in districts where the lime is deficient. The following figures show the results he obtained from Baden and Thuringia:—

(1) Country Places Poor in Lime.

	Percentage of Children with Caries.	Percentage of Diseased Teeth.
In Baden	98·7	35·3
In Thuringia	92	34·9

[1] From *Dental Cosmos*.

(2) Country Places Rich in Lime.

	Percentage of Children with Caries.	Percentage of Diseased Teeth.
In Baden	79 ...	16·1
In Thuringia	82·8 ...	16·7

Röse found a remarkable difference in the amount of caries in children at two villages, Guntersthal and Uffhausen, only about three kilometres apart. At the former, where the geological formation is gneiss and the water 1·7 to 2·8 degrees of hardness (German calculation), in 118 children 34·6 per cent. of the teeth were carious, while at Uffhausen, where a Jura-lime formation exists, and the water was 14 to 19 per cent. of hardness, in 162 children the percentage of carious teeth was 20·7.

More recently J. B. Cook[1] has investigated the subject in 80 urban districts in England and Wales. He finds that the harder the water the better the teeth, and, what is also of interest, that the harder the water the lower the infantile mortality. The relation of the hardness of the water to the incidence of caries must not necessarily be regarded as cause and effect but rather as a factor in the degree of relative immunity.

The Type of Organisms present in the Mouth.—Investigations carried out by Pickerill and Champtaloup[2] show that in Maori children, who are comparatively immune to caries, the organisms present in the mouth are morphologically similar to those found in the mouths of individuals belonging to the more highly civilized communities; a fact which indicates that susceptibility and immunity to caries do not depend upon the bacteriological flora of the mouth.

The position of the teeth in relation to one another has an important bearing on their liability to caries. When they are in regular position the surfaces are easily kept clean by artificial means, such as the tooth-brush, silk and tooth-pick in conjunction with the natural cleansing action of the tongue and lips; but when they are placed irregularly inaccessible crevices are formed. Again, the teeth, when normally placed, only just touch one another at the crowns and the space at the necks is occupied by gum which prevents the lodgment of food. Any agency, therefore, which operates to change these conditions, for example, causes a loosening or recession of the gum, acts as a predisposing cause of caries.

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[1] "The Effects of Drinking-water upon the Causation of Dental Caries in School Children," *Lancet*, March 28, 1914.

[2] *New Zealand Dental Journal*, March, 1914.

The Self-cleansing Action of the Mouth.—If a series of mouths be examined about fifteen minutes after a meal it will be found that the amount of food débris present varies; in some mouths the teeth will be entirely free from food while in others there will be a considerable deposit around and between the teeth. It is obvious, therefore, that some mouths are self-cleansing and others are not, and it is highly probable that the character of the mouth in this respect affects the relative immunity or susceptibility of the teeth to caries. F. Breeze[1] has recorded some interesting facts in connection with this question. In schools brought under the same dietetic regime and the same discipline with regard to artificial cleansing of the teeth, he found that the incidence of caries was in ratio with the self-cleansing action of the mouth. The children were inspected immediately after meals and the degree of cleanliness of the mouth noted. During one inspection, he found that (1) of 39 children (immune), in only 7 cases was food found and then only on the occlusal surface of the molars; (2) of 30 children (non-immune), 21 cases had food remaining on the teeth and in 7 of these there was marked accumulation.

The Possibility of the Formation of Antibodies in the Teeth.—Von Beust[2] has shown that if the ends of the roots of freshly extracted teeth are immersed in a strong alcoholic solution of fuchsin the crowns will in time take on a reddish hue, which is due to the passage of the stain from the pulp cavity into the enamel. He therefore assumes that plasma "can reach all parts, generally speaking, of the enamel and that this renders it possible, nay even probable, that the immunity to caries observed in some teeth lies in the tooth itself and is the result of the formation of antibodies." He does not, however, exclude the saliva as an active factor in influencing immunity.

The Saliva.—A strong flow of saliva flushes the mouth and removes particles of food from the teeth. Miller affirms that he has repeatedly found that a cessation or a marked diminution in the secretion of saliva is followed by acute caries, which attacks nearly all the teeth simultaneously and often extends upon the free surfaces. A viscid saliva may also conduce to caries by interfering with the self-cleansing of the mouth. It seems possible also that the susceptibility to caries may be influenced by the constitution of the saliva, for Miller,[3] as the result of many experiments, came to

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1 *Brit. Dental. Journ.*, June 16, 1913.

2 *Dental Cosmos.*

3 *Dental Cosmos*, 1903, p. 689.

the conclusion that " the saliva of those immune to caries develops in the presence of carbohydrates, in and out of the mouth, on an average a little less acid than that of highly susceptible persons. The difference is, however, not constant, and is not sufficiently marked to account for the marked differences of susceptibility."

Röse[1] has analysed the saliva of 219 children whose average age was 13 years, and he concludes that a distinct relation exists between dental caries and the alkalinity of the saliva. He finds that a high alkaline reaction constitutes the best means of checking the progress of caries. He has carried out a considerable number of experiments to determine the means by which slightly alkaline or acid saliva may be modified so as to render its reaction decidedly alkaline. He finds that a diet consisting of food-stuffs rich in calcium salts increases the alkalinity and quantity of the saliva and he believes that such a diet favourably influences the quality of the teeth. In this connection it is interesting to note that Miller, in comparing experimentally equine and human saliva, found that in equine saliva no acid was produced during the first twenty-four hours, and that the total amount at the end of nine days was 50 per cent. less than in human saliva. Equine saliva is strongly alkaline and therefore more readily neutralizes any acid formed. In chapter XX reference is also made to the part played by saliva in relation to caries of the teeth.

The Relation of Sulpho-cyanide of Potassium to Caries.—A considerable difference of opinion exists as to the relation of sulpho-cyanide of potassium to caries. This salt is a normal constituent of saliva, forming about 0·1 of the total solids. Gies[2] has made a thorough investigation into the subject and finds that " there is nothing about the known quantities of sulpho-cyanide to indicate that it is able, *in the proportions of its normal occurrence in saliva* to affect the secretory tendencies of the salivary or buccal glands, to modify the oral membranes, to influence the teeth from any standpoint, or to stimulate or retard or alter the activities of the oral micro-organisms."

Vaccination.—So careful a thinker as Herbert Spencer hazarded the suggestion that vaccination might increase the susceptibility of the teeth to caries. This view is shared by a few dental practitioners. D. V. Beacock[3] considers that vaccination is a prime

[1] *Deutsche Monatsschrift für Zahnheilkunde,* December, 1905.

[2] *Dental Cosmos,* February, 1914.

[3] *Dominion Dent. Journ.,* December, 1901.

factor in the destruction of children's teeth, his argument being that it leads to imperfect development of the tooth structure. Reliable statistics in support of this view are not, however, forthcoming.

Pregnancy.—It is a current belief that there is increased susceptibility to caries during pregnancy and it has been assumed that this is due to the absorption of the mineral matter from the teeth to form fœtal bone. From a physiological point of view there would appear to be no foundation for this belief. Dr. S. Biro[1] has examined the teeth of 200 mothers and the results he obtained tend to show that pregnancy does not cause any increase in caries of the teeth. During pregnancy certain women often seem more liable to caries, but an explanation may be found in some change of the oral secretions which furnish a more favourable soil for the development of micro-organisms. It is possible that the vomiting of pregnancy may, to some extent, aid the development of caries. This apparent predisposition of the pregnant to caries is by no means a matter of general experience, and in practice one meets with many instances of women with large families who have excellent teeth and who develop no increased susceptibility to caries during the pregnant period.

The Influence of Feeding in Infancy.—The dental profession is far from unanimous as to the effect of infant feeding on the susceptibility to caries. Kingston Barton,[2] as a result of twenty years of observation, finds that breast-fed children have the best teeth; those fed on cows', asses' or goats' milk come next, and that when starch or any patent food is added to or given in place of cows' milk, the teeth, both deciduous and permanent, almost always suffer badly. The figures published in the report of the Salop County Council show that the incidence of caries in breast-fed children is only slightly less than in the bottle-fed. The figures are as follows:—

Age	Breast-fed Children: Number of children examined	Breast-fed Children: Number of carious teeth per child	Bottle-fed Children: Number of children examined	Bottle-fed Children: Number of carious teeth per child
5 to 6	5,707	6·7	3,375	7·1
12 ,, 13	3,571	4·7	1,900	5·0

Adenoids.—Statistics show that caries is more prevalent in mouth-breathers than in nose-breathers, and this is no doubt due to the facts that in the mouth-breather (1) food débris is more liable

[1] *Oesterreich-Ungarische Vierteljahrsschrift,* October, 1898.

[2] *Medical Press and Circular,* vol. ii, 1899.

to cling around the teeth, and (2) the number of micro-organisms is increased. The following figures published by H. R. Burpett[1] are of interest:—

	Children with Adenoids			All Children		
	Infants Per cent.	Intermediates Per cent.	Leavers Per cent.	Infants Per cent.	Intermediates Per cent.	Leavers Per cent
Teeth excellent	7	10	12	13·2	12·6	18·5
Four or more teeth carious	33·5	28	12	26·4	21·4	10·4

Poverty.—In discussing this aspect of caries, comparisons will be drawn between the various classes of children who attend State schools, such children usually not having had the advantage of dental treatment. Statistics show that amongst such children the poorest have the best teeth. The following figures are taken from an inspection of children in Staffordshire[2]:—

	Age 5—6		Age 8—9		Age 12—14	
Sound dentures among—	Number examined	Per cent.	Number examined	Per cent.	Number examined	Per cent
(*a*) All children coming from houses, one to three rooms	478	23·2	379	12·6	159	22·6
(*b*) All the other children attending the same schools as the children in (*a*)	2,434	20·2	2,445	7·5	1,025	18·2
(*c*) All the children of all the schools of the county	6,485	18·3	6,198	8·4	3,421	18·9

The general high percentage of sound dentures requires a word of explanation. In the inspection no probe or mirror was used; hence many carious cavities must undoubtedly have been missed. The figures, however, are comparative and distinctly show that the poorest children have the best teeth. The poorest children have the most simple food, while lack of means prevents the purchase of cakes and sweets, and the better preservation of their teeth is probably due, therefore, to the comparative absence of the highly fermentable carbohydrates from their diets.

(G) ETIOLOGY

In the preceding pages it has been shown that caries is a process which is started by solution of the inorganic matter of the teeth and continued by the peptonizing action of bacteria on the remaining organic tissue, and that the acid or acids which cause the

[1] Quoted in *Dental Record*, November, 1916, p. 603.

[2] Annual Report of the School Medical Officer, Staffordshire County Council, Year 1911.

damage are formed from the carbohydrate food undergoing fermentation in contact with the tooth substance.

We have seen that caries existed as far back as the "Stone Age," though it was probably then very rare. In the early stages of civilization a definite increase in the amount of caries can be traced, and with the spread of civilizing influences the disease has made more and more rapid progress until at the present day it is so prevalent that few are to be found with teeth entirely free from caries.

The phenomenal rapidity with which caries has increased during the last few decades has puzzled those who have studied the subject. Considerable light has, however, in recent years been thrown on the problem by those who contend that a solution is to be found in the altered character of the food-stuffs. In a series of valuable papers, Sim Wallace has drawn attention to the influence which the refinement of food has had on the process of mastication, and he has clearly pointed out the intimate relationship which this change bears to the incidence of caries. To appreciate the standpoint taken up by this writer, reference must be made to the process of mastication of food of a soft character, and of food containing coarse or fibrous material. In the former case "The food is simply taken into the mouth, receives a general squash between the teeth, or between the dorsum of the tongue and the hard palate, and is then swallowed. This method of mastication—if mastication it can be called—is, as a rule, adopted for custards, fine meal porridge, soft puddings, and soft non-fibrous foods generally. When there is a certain amount of coarse or fibrous matter in the food-stuff, the process is essentially different, and mastication is performed in a more thorough manner. The food is crushed and torn between the teeth and heaped on to the masticating sufaces by the muscular contractions of the tongue, cheeks, lips, and motions of the lower jaw. During comminution between the teeth, the juices of the food-stuffs, the saliva which becomes incorporated, and the suspended non-fibrous part are pressed out from the fibres and gradually collect during the process on the middle of the dorsum of the tongue, which is gradually hollowed out for the reception of such food, and this portion of the food is then swallowed. The fibrous part of the food, however, is subjected again and again to the crushing and disintegration between the teeth. If any of the fibrous part passes towards the back of the dorsum of the tongue, it is arrested by the pressure of the anterior part of the tongue against the rugæ of the palate, and while the fluid and finely comminuted part gets sucked or pressed back into the hollow formed at the back

of the dorsum of the tongue, the coarse and fibrous parts are thrown between the teeth and subjected again to the crushing, squeezing and comminution. The rough surface of the tip and dorsum of the tongue and the smooth-ridged palate are especially well adapted for separating the food which is prepared for swallowing from that which requires further mastication.

"If this process is carefully observed, it will be found that the food is not, as a rule, formed into a bolus and then swallowed, but that the bolus is continually slipping away to the dorsum of the tongue, to be swallowed only when there is almost or quite no bolus left." (Sim Wallace.)

The recognition of the real nature of the process of mastication is, in this author's opinion, of great importance, for the effect of chewing food of a more or less fibrous nature tends to dislodge the fine particles of food-stuffs which otherwise are apt to lodge between and on the teeth.

If we examine the food-stuffs as prepared for the table at the present day, we find that every care has been taken to eliminate the fibrous element, and that they are usually presented in such a soft condition as to require very little mastication; indeed, it is extremely difficult even with the best intentions to masticate such food. The process of mastication, therefore, remains in abeyance, and the result is that, owing to the pappy character of the food, and the absence of the cleansing operation of mastication, the food tends to cling around the teeth. Sim Wallace contends that herein lies the true cause of the prevalence of caries. He says: "The cause of the prevalence of dental caries is that the natural food-stuffs are to a large extent ridded of their accompanying fibrous parts and prepared and consumed in a manner which renders them liable to lodge and undergo acid fermentation in the mouth; while from the same cause and the induced condition the micro-organisms of the mouth lodge, multiply and augment the rapidity and intensity of the acid fermentation."

In opposition to these views it is argued that there are numerous examples of races living upon soft food and yet not unduly liable to caries. The Kaffirs of South Africa are given as an instance. The porridge of the Kaffirs, which is their staple food, is prepared by bruising and crushing mealies, no attempt being made to eliminate the coarse and fibrous parts, and experience shows that such food *does* require a considerable amount of mastication.[1]

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[1] References to this question will be found in the *Lancet*, September 8, 1900, p. 770; November 3, p. 1307; *Brit. Med. Journ.*, March 18, 1905, p. 629; April 1, p. 749.

My brother, Stanley Colyer, who has lived for several years among the races of Central Africa has shown that the diet of many of these people is mainly " grain," and that it is prepared for eating in a " stodgy, elastic and rather sticky mass," which requires but little mastication. The natives do not clean their teeth after meals, and their diet is practically free from " acid and saltish savouries." The food, however, is practically free from easily fermentable carbohydrates, in the form of the *various* sugars. These races have very little caries, and it would therefore seem that caries cannot be solely attributed to soft, sticky, starchy foods.

Although there is much to be said in favour of Sim Wallace's view, it is very doubtful whether it offers a complete solution of the problem. It is more highly probable that there have been other agencies at work tending to accelerate the progress of caries. The use of carbohydrates has probably had an important influence in this direction. *Carbohydrates as used at the present day are more easily soluble and fermentable than heretofore*, and within the last fifty years have undergone an extraordinary amount of variation. Flour is a typical example. In flour the change has been brought about by the altered method of milling. Milling with the old stone mills excluded no part of the grain except the greater portion of the husk, whereas with roller milling the germ is removed and practically all the bran, the flour consisting almost entirely of starch and gluten. With regard to the question of caries, bread made from stone-milled flour requires more mastication and insalivation than that made from the roller-milled, and what is probably more important still, is that the much finer subdivision of the starch granules in the roller-milled flour offers an increased surface for the action of fermentation.

It has been said that the acidity produced by white flour is greater than that of stone-milled flour. Experiments carried out by Leonard Hill[1] do not confirm this statement. This author tested the acidity of a weighed quantity of standard and white bread chewed in the mouth for two minutes and found no difference in the amount of acid produced. The subject, however, is deserving of serious attention, seeing that bread and flour form the most important item in the diet of the masses.

Clinical evidence supports the view that there is an intimate relationship between sugar and caries. The use of sugar as a food-stuff has increased enormously during recent years and this food,

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[1] "A Preliminary Note on the Nutritive Value of White and of Standard Bread," *Brit. Med. Journ.*, May 6, 1911.

it must be remembered, is readily soluble. Miller[1] would seem to have held the view that the importance of sugar was over-rated. He remarks: "At present sugar is universally regarded by dentists as well as laymen as injurious to the teeth." Again (p. 207), he states "that sugar, being readily soluble, is soon carried away, or so diluted with the saliva as to be rendered harmless," and he considered that the chief rôle in the production of decay was performed by bread, potatoes, &c.

Cane and beet sugars are polysaccharides and before fermentation must undergo the process of inversion; glucose, on the other hand, is a monosaccharide and is, therefore, directly fermentable. Within the last thirty years glucose has been used extensively as a substitute for sugar and enters largely into the manufacture of syrups, candies, jams, cheap sweets, &c. In the manufacture of glucose a gummy body, namely dextrin, is formed, and this possibly assists the retention of the sugar in the mouth.[2] It has been suggested that glucose is rapidly fermentable, but this requires experimental proof, and the question of the varying rapidity of fermentation of the carbohydrates used as foods opens up a wide field for research. "There can be no doubt that a mistake has been made in the past in regarding all sugars as similar, and that, in the future, in their relation to caries, they must be looked upon as different substances, transformable, to some extent, into each other; just as peptone, being a proteid, is a changed form of other proteids though possessing many different properties."

In a paper by L. Ottofy on "The Teeth of the Igorots,"[3] the relation of sugar to caries is well brought out. In the Igorots of the Philippines, a semi-barbaric race, he found only 2·05 per cent. of carious teeth; while in the Filipinos, the more civilized inhabitants of the islands, the amount of caries was 20·9 per cent. The diet of the Igorots consists of food requiring considerable mastication; bread is unknown and sugar is distasteful to the children. The Filipinos, on the other hand, indulge freely in the practice of chewing sugar, which is sold in small pieces all over the islands, and Ottofy is convinced that the extensive amount of caries in the Filipinos is due to sugar. There is abundant clinical evidence to show that the use of sugar is closely connected with the amount of caries. In practice it is found that children who eat sweets in

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1 "The Micro-organisms of the Human Mouth," p. 145.

2 See paper, "The Problem of Dental Caries," S. Colyer, *Dental Record*, vol. xxiv, p. 301.

3 *Dental Cosmos*, July, 1908.

large quantities will return from school each term with a plentiful supply of fresh and generally rapid caries, but when the eating of sweets is stopped the amount of fresh caries rapidly declines.

Here again the recent reports of school officers are of value. In the County of Shropshire an inquiry was carried out to ascertain the relation of "sweets" to caries, the term "sweets" being used with the popular meaning and not including sugary foods taken at meal times. The classification adopted was:—

Class 1. Large quantities of sweets eaten—almost every day.

Class 2. Considerable quantities eaten—several times a week.

Class 3. Few sweets eaten—about once a week.

Class 4. No sweets at all eaten.

In all 5,856 children were examined, and it was found that there was a large preponderance of caries amongst the children eating sweets in quantity. The fewer the sweets the less the number of carious teeth and the greater the percentage of sound dentures.

Recapitulation.—The process of caries may be concisely described as follows: The form and relative positions of the human teeth favour the lodgment of food-stuffs in solid form or in solution upon or between the teeth. Of the three groups of food-stuffs—nitrogenous food, the carbohydrates, and fats—the second group is particularly concerned in bringing about the process of caries.

Of the three groups of carbohydrates—cellulose, starch and sugar—it is doubtful whether the first (cellulose) undergoes any change in the mouth which gives rise to products injurious to the teeth; whereas starch is first converted into dextrose by the action of the ptyalin of the saliva, and the dextrose, through the agency of micro-organisms (fermentation) into lactic acid, and possibly other organic acids in minute quantities. The sugars, when directly fermentable, are by the same process converted into acids, whereas those not directly fermentable, such as cane-sugar, take up a molecule of water under the action of invertin (a ferment produced by many bacteria), and are then split up into dextrose and levulose, both of which are directly fermentable, and produce lactic acid in the presence of many mouth bacteria.

These acids, from whatever source produced, attack the teeth at the point where they are generated, that is, wherever the foods in solid or fluid form have lodged on or between the teeth, and lead to decalcification, first of the enamel (or cementum), and later of the dentine. The decalcification of the enamel results in its complete destruction, as the organic substance in the enamel is insufficient to hold together after decalcification, whereas decalcification of the dentine does not imply the complete destruction of

the organic basis, as this remains in the form of the so-called tooth cartilage. As this organic basis is of a nitrogenous nature it undergoes decomposition in very much the same way as all other nitrogenous substances exposed to the action of bacteria in the presence of moisture and a suitable temperature. The agent which brings about this decomposition is a ferment produced by many of the bacteria of the mouth and acts in very much the same way as the pepsin of the gastric juice, except that it does not require the presence of acid. Very little is known as to what changes of a fermentative nature take place in the fats in the mouth. It is possible that a fermentation leading to the formation of fatty acids may occur, but if that is the case the quantity produced is so minute that it has not as yet been detected.

Nitrogenous substances, as already explained above, undergo very active decomposition in the mouth, resulting, however, not in an acid, but in an alkaline reaction; an excess of nitrogenous food —for example, a diet consisting chiefly of meat—might serve to arrest the process of decay, inasmuch as the acids produced in the mouth by the fermentations of carbohydrates would be in part, or completely, neutralized by the alkaline products arising from the fermentation of nitrogenous food.

A consideration of the question of etiology would seem to suggest that the prevalence of caries in modern races is due to the soft character of the food, and the increase in the use of carbohydrates, which undergo rapid fermentation.

(H) SYMPTOMS

Pain in the region of the affected tooth may occur. If the caries is on a surface free to the tongue, the patient will be conscious of a cavity. In many instances, the lodgment of food between the teeth is the first symptom noticed. The pain is due to irritation of the fine termination of the nerves in the dentinal tubules, and will vary according to the situation and extent of the cavity. On occluding surfaces, the fibrils being exposed, changes of temperature or the introduction of irritant substances into the cavity will produce pain which increases in severity as the cavity becomes larger. In cavities tucked away under the gum or on approximal surfaces, pain is often not felt until the pulp is involved. The degree of pain varies with different temperaments, and in the same individual at different periods. Patients of a nervous temperament suffer more than those of a lymphatic temperament. In a few patients, caries gives rise to no pain.

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CHAPTER XIII

The Treatment of Caries

Prophylactic Treatment—Remedial Treatment—The Preparation of Cavities—Hypersensitive Dentine—The Use of Matrices—Use of Screws for Retaining Fillings—The Materials used for Filling Teeth—The Introduction of the various Filling Materials—The Operation of Excision—The Use of Drugs in the Treatment of Caries—The Operation of Crowning—The Operation of Extraction.

The treatment of caries may be divided into

(A) Prophylactic.

(B) Remedial.

(A) PROPHYLACTIC

Rational treatment of caries, like the rational treatment of any other disease, must depend upon the knowledge of the etiology of the disease. When a disease can be traced to its source its eradication can generally be quickly accomplished by the adoption of energetic preventive measures, and as an excellent example the stamping out of Malta fever may be quoted. For years this severe and dangerous complaint played havoc with our naval and military forces stationed at Malta and other parts of the Mediterranean, and, indeed, in many other parts of the world. The study of this disease was approached by experimental methods in 1887, and the knowledge thus gained, combined with scientific reasoning, resulted in the infection being traced to its source, namely, the milk of goats. With the banishment of goat's milk from the dietary, the fever has become practically extinct in the Army and the Navy.

Although, during recent years, advances have been made in our knowledge of the etiology of dental caries, we cannot yet claim that we know the true cause of the disease.

In discussing the cause of caries, attention was drawn to certain matters which appear to have a special bearing on the increase of caries, namely, the feeding in infancy, and the character of the food-stuffs, &c. A consideration of these matters seems to indicate

that preventive treatment should be based somewhat on the following lines:—

(*a*) The insistence when possible of breast-feeding.

(*b*) The consumption in the early years of life of food-stuffs which require efficient mastication.

(*c*) The use of carbohydrates which are not easily fermentable.

With regard to *breast-feeding*, it is true that this natural function cannot always be performed. Too often, however, hand-feeding is substituted, not so much from inability of the mother as from an unnatural desire on the part of the mother to escape the ties which the duty of breast-feeding involves. When, however, breast-feeding is impracticable, every care should be taken to ensure that the hand-feeding is carried out in a proper manner, and it is satisfactory to find that a great advance in this direction has been made in recent years.

The use of *food-stuffs* which require some effort in mastication is important, and "pap" food should, as far as possible, be carefully avoided. A very little experience of children will bring home the importance of this point. Bread soaked in milk is bolted, while bread given in the shape of a crust or a piece of toast is chewed, simply because the chewing is physiologically necessary. For similar reasons, meat, when given, should be cut in strips and not minced. Mastication promotes a healthy flow of saliva and the saliva assists in cleansing the teeth.

There is little doubt that of the carbohydrate foods, the sugars are the most harmful, especially when taken between meals. *"Sweets" as popularly understood should be forbidden.* As carbohydrates are now known to be the source from which the lactic acid is derived, it is advisable so to arrange a meal that the last food-stuff taken is neither a sugar nor a starch. A meal should, if possible, finish with fruit or cheese. Fruit is especially beneficial, as it is slightly acid and stimulates the saliva. Meals should be given at regular intervals. If the salivary secretion is constantly being stimulated by incessant "nibbling" at food, it is probably robbed of its physiological properties and the supply required for the regular meals is depleted and probably altered in character.

A functional mouth is a necessity if caries is to be prevented. There are two important factors militating against a functional mouth: one is mouth-breathing and the other the presence of tender teeth. Mouth-breathing, as shown on p. 582, leads to a persistent marginal gingivitis which aids the retention of food around the teeth. It is therefore essential that any condition

causing nasal obstruction should be removed in order to admit of correct breathing. Tender teeth prevent mastication, and without proper mastication it is difficult to keep the teeth clean. The mouth, then, must be freed of all tender teeth, either by filling or extraction.

The proper cleansing of the teeth after meals is a most important prophylactic measure, but this must be regarded as secondary in importance to the measures just referred to. If possible, the teeth should be cleaned after every meal, but it is especially needful after the last meal of the day. During sleep, the saliva ceases to flow, and it is then that the main fermentation of the food occurs. The tooth-brush should be small and contain fewer bristles than the brushes usually sold; the bristles should be of different lengths, so as to permit of their passing more easily into the interstices of the teeth. The following instructions for cleaning the teeth are issued to the patients at the Royal Dental Hospital of London:—

(1) The teeth **must** be kept clean.

(2) Use a small tooth-brush with stiff bristles. Use a little soap and some precipitated chalk.

(3) Brush all the teeth thoroughly, especially the back ones. Brush all surfaces of the teeth.

(4) Rinse the mouth thoroughly with clean water.

(5) Clean the teeth immediately **before going to bed.** Take no food of any sort afterwards. Clean the teeth again in the morning.

(6) **Clean teeth do not decay.**

With the eruption of the permanent incisors, the spaces between the teeth should be regularly cleared with silk.

In mouths **where caries is progressing rapidly,** it is a useful measure to swab the mouth with an alkali the last thing before going to rest, for example:—

Mag. carb. levis	... ...	ʒiv.
Aq. rosæ	... ...	℥vi.
Aquam	... ...	ad ℥xij

Misce. Shake before using.

After cleansing the teeth, a tablespoonful of the above should be taken into the mouth and sluiced between the teeth.

In cases of acute fevers or any other condition where the patients are helpless, their teeth should be cleaned by the attendants.

Patients wearing dentures should be warned of the danger of neglecting to cleanse both the mouth and the dentures, especially where there are bands or clasps. Dentures cause caries only in so far as they assist in retaining food around the teeth.

In mouths showing a tendency to approximal caries of the anterior teeth, isolation should be obtained by the removal of the first or second premolars or the first molars (see p. 207). Isolation of the incisors and canines is a most valuable method of preventing caries between these teeth.

(B) REMEDIAL

The remedial treatment may be considered under the following headings:—

(1) The operation of filling.
(2) The operation of excision.
(3) The use of drugs.
(4) The adaptation of artificial crowns.
(5) The operation of extraction.

(1) THE OPERATION OF FILLING

(*a*) The Preparation of Cavities

It is not intended to describe fully all the various types of cavities and methods of inserting fillings which occur in practice; attention can be directed only to the more salient and elementary points. The manipulative skill required for correctly filling teeth can only be acquired by practice.

(i) General Points.—Success in filling depends largely upon a careful preparation of the cavities. The cavity in the tooth should first be freely opened up by means of fissure burs and enamel chisels and *all* the carious dentine removed. In the *retentive shaping*, care must be taken to avoid injury to the pulp and needless sacrifice of tooth substance which might endanger the stability of the cavity walls. *The simplest mode of shaping is to cut the cavity so that some part of the interior is a little larger in diameter than the diameter of the orifice.* In cavities with all the walls standing, this may be effected by making the walls slightly divergent from the orifice inwards. With cavities not possessing four walls, retention is usually obtained by means of *grooves*. The grooves must not be too deep; a deep groove is difficult to fill, and is a source of weakness. The grooves must be cut in the dentine, and in a direction parallel with the pulp. A frail margin of enamel

should not be allowed to remain at the cervical portion of the cavity. For example, in fig. 485 the margin of enamel is frail, and liable to fracture during filling. The cavity should be extended so as to remove all the enamel.

The extension of cavities beyond the actual limit of the caries is often advisable in order to remove possible sources of failure and obtain "*self-cleansing*" *edges*. If there are two or more cavities in a tooth and there is little intervening tissue between them, the

Fig. 485.

Fig. 486.

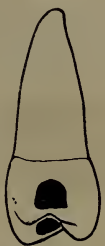

Fig. 487.

intervening tissue should be removed. Examples: On the occluding surface of a maxillary molar, cavities frequently exist in the anterior and posterior sulci, and if only a thin stretch of tissue remains when the cavities are prepared (fig. 486), it is better to unite them. With cavities in the approximal surfaces (see fig. 487) the intervening tooth structure should be removed, otherwise fracture is certain to occur from the force of mastication. With cavities on the occluding surface of the premolars and molars the fissures should be freely cut out.

Fig. 488.

Fig. 489.

When the wall of a cavity is in close proximity to a fissure (fig. 488), the cavity should be extended so as to include the fissure (fig. 489). The extension of cavities so as to ensure "self-cleansing" edges is most desirable. All joints between fillings and tooth substance should be made as accessible as possible to the tongue and tooth-brush, in order that food may be prevented, as far as possible, from lodging near them. It is also most desirable

that *fillings should be in contact with the approximal teeth* to prevent injury to the muco-periosteum during mastication (figs. 490 and 491).

The Treatment of the Enamel Margins.—The best results are obtained by keeping the margin at right angles to the teeth in all

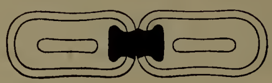

Fig. 490.—Diagram showing cavities prepared in such a way that the junction between the filling and enamel cannot easily be kept clean.

Fig. 491.—Diagram showing cavities prepared in such a way that the junction between the filling and enamel can easily be kept clean.

except occluding surfaces (fig. 492). If the edges on occluding surfaces are left much undercut, a few enamel fibres will be unsupported by dentine—the fibres always run at right angles to

(*a*) Enamel margins incorrectly prepared.

(*b*) Enamel margins correctly prepared.

Fig. 492.

the external surface of the enamel at that position—and the result will be that, with pressure, they will give way and form a vulnerable point in the filling (493 (*a*)). If, however, the margin is left

(*a*) Showing how not to leave the margins of enamel.

(*b*) Showing how the enamel margin should be prepared.

Fig. 493.

only slightly bevelled, all the enamel fibres will be supported by dentine and a source of failure will have been removed (fig. 493 (*b*)).

The best instruments for carrying out this part of the work are fine-cut cavity burs and stones.

(ii) Relation of the Pulp Canals to the Surfaces of the Teeth. —Maxillary Teeth.

(*a*) *Incisors.*—The pulp of the *central incisor* follows to a great extent the contour of the tooth. It is prolonged towards the mesial and distal angles (fig. 494); care must therefore be taken to avoid cutting deeply in this part of the tooth. A section of the tooth near the neck shows that the pulp lies a little nearer to the labial than to the palatal aspect of the tooth; pits and grooves can therefore be made with greater safety in the palatal part of the tooth. Access to the pulp canal should be gained through the palatal aspect of the tooth, the opening being made below the pit (fig. 495) and not through it. An opening made through the pit will meet the canal at an angle. The nearer the opening is made towards the cutting edge the more direct will be the access to the canal. The direction in which an approximal cavity should be extended to open the pulp canal is shown in fig. 496.

Fig. 494.

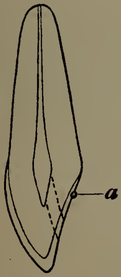

Fig. 495.

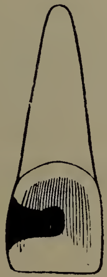

Fig. 496.

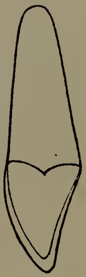

Fig. 497.

The enamel on the approximal surfaces ends as shown in fig. 497. This fact must be taken into consideration when preparing the cervical portion of the cavity.

The pulp of the *lateral incisor* is practically similar in shape to that of the central, but it is larger in proportion to the size of the tooth and is therefore more often exposed.

(*b*) *Canine.*—The pulp is not prolonged towards the mesial and distal angles as in the incisors. In comparison with the incisors, the pulp is relatively small. Access to the pulp canal should be gained through the palatal aspect of the tooth. The nearer the opening is made towards the cutting edge the more direct will be the access to the canal.

(*c*) *Premolars.*—In the *first premolars* there are usually two canals. The pulp is constricted at the neck (see fig. 498). In

extending cavities to the pulp canal, it is almost always necessary to cut towards the cusps, as shown in fig. 499.

The *second premolar* usually has one root canal. The pulp is not so constricted at the neck as it is in the first premolar. Access to the pulp canal is gained in the same manner as with the first premolar (see fig. 500).

FIG. 498.

FIG. 499.—Showing method of opening into the pulp canals of a first premolar from the occluding surface.

(*d*) *Molars.*—The *first molar* has three roots. The pulp approaches the anterior aspect of the tooth more than the posterior, and is therefore more liable to be exposed in anterior than in posterior cavities. The relative position of the orifices of the canals is shown in fig. 501. The direction of the axis of the pulp canals towards the occluding surface is seen in fig. 502. Access to the

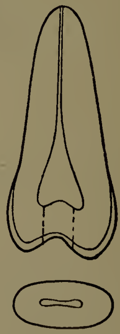

FIG. 500.

canals is gained by extending the cavities towards the buccal surface (see fig. 503). By this means, direct access to the buccal and palatine roots can be obtained.

The *second molar* has three roots. The palatine root is more in line with the longitudinal axis of the tooth than is the case with the first molar, and for this reason access to the canals should be

gained by extending the cavities towards the centre of the occluding surface rather than towards the buccal aspect. The pulp, as in the first molar, is situated nearer to the anterior than to the posterior aspect of the tooth.

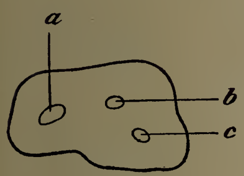

FIG. 501.—(*a*) Palatine root; (*b*) posterior buccal root; (*c*) anterior buccal root.

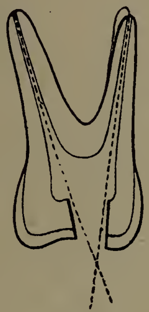

FIG. 502.

FIG. 503.

Mandibular Teeth.

(*a*) *Incisors and Canines.*—Access to the pulp chambers of these teeth should be gained by an opening on the lingual surface, the opening being made well towards the incisive margin (figs. 504 to 505).

FIG. 504.—Showing method of approaching the pulp canal in a mandibular incisor.

FIG. 505.—Showing method of approaching the pulp canal in a mandibular canine.

(*b*) *Premolars.*—The crown of the *first premolar* is slightly bent on the root, the inclination being towards the tongue. A section of this tooth shows that direct access to the pulp canal is best gained by drilling through the lingual aspect of the buccal cusp (see fig. 506). In extending approximal cavities to the pulp canals the operation should be carried out as shown in fig. 507. The usual method of extending the cavity through the coronal fissure will

strike the pulp canal at an angle, while extension as advised will give direct access to the canal.

With the *second premolar*, the inclination of the crown to the tongue is not so marked, extension to the pulp canal should therefore be made by cutting a little more towards the coronal fissure (see figs. 508 and 509).

(*c*) *Molars*.—The *first molar* has two roots. The canal in the anterior root is much constricted in the centre, while the pulp canal in the posterior root is well marked. Access to the pulp canals should be gained by extending the cavity towards the central portion of the occluding surface.

The *second molar* has two roots. The pulp canal in the anterior root is not, as a rule, constricted as in the first molar. Access to the canal is gained in a way similar to that pursued with the first molar.

Fig. 506.

Fig. 507.

Fig. 508.

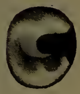

Fig. 509.

(iii) Simple Cavities.—The simplest form of cavity is that in which all the walls are complete, and good examples of this are the cavities occurring upon the crowns of molars and premolars. To shape these, the walls should be made slightly out of the perpendicular, the floor being left flat and the edges trimmed as directed. All fissures on the occluding surface must be freely cut out.

In preparing simple cavities the *modus operandi* is as follows: Example: carious second mandibular molar (fig. 510). With a fissure bur a cut is made through all the fissures (see fig. 510 (*a*)). An enamel chisel is then used to break down any triangular pieces of enamel thus left (fig. 510 (*b*)). The carious dentine is then removed with suitable instruments and the walls correctly shaped (fig. 510 (*c*)). When using cohesive gold in mandibular molars, it is often found that if the anterior wall is undercut, or even quite perpendicular, the cavity is extremely troublesome to fill. To overcome this difficulty the anterior wall should be left quite sloping (fig. 511), and then it can be easily seen, and the cavity properly

filled, the filling being held in by making the buccal and lingual walls of the cavity diverge slightly towards their posterior aspects.

For simple cavities on the labial, buccal and lingual surfaces,

(*a*) Showing tooth before preparation.

(*b*) The dotted lines show the portion of enamel to be removed by the enamel chisel.

(*c*) Cavity prepared. Note: the margins should be left a little more rounded than shown in diagram.

FIG. 510.

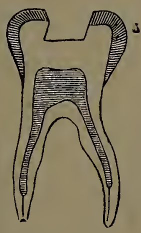

FIG. 511.

the rules as to simple crown cavities apply. For cavities on the incisive margin of the anterior teeth, a slight undercut should be made throughout the breadth of the cavity. The edges must be

FIG. 512.—Cavity involving cutting edge of central incisor. Transverse section showing method of preparing cavity.

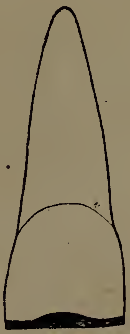

FIG. 513.—Showing cavity filled

prepared in such a way that the filling, when inserted, completely covers them, otherwise failure through fracture of the enamel margins is liable to occur (figs. 512 and 513).

(iv) Approximal Cavities.—In cavities on the approximal surface (fig. 514) of the *molars and premolars* access must be gained through the occluding surface. This is carried out with a small fissure bur, the cut being taken well back on the coronal aspect. The weak edges of enamel (see dotted line, fig. 515) are then broken down. The carious dentine is next cleared away. A cavity somewhat cup-shaped will then be left to deal with (fig. 516). In the shaping it must be remembered that there are two directions in which the filling has to be prevented from coming out, the one from above downwards, the other laterally. The labial and lingual walls (*a* and *b*) should therefore be cut so as to diverge not only towards the cervical margin, but also towards the axial portion of the tooth. To carry out this step two grooves are made which diverge as they approach the cervical margin (fig. 517). The portion of tissue shown by the dotted lines is then removed, and a double wedge-shaped cavity is obtained.


FIG. 514.


FIG. 515.

FIG. 516.


FIG. 517.

Should the fissure in the coronal surface be carious, it must be cut out, but in doing this as little tissue as possible should be removed in the case of premolars. In these teeth, if large cavities are present on both anterior and posterior surfaces, the inner cusp is liable to fracture; the retention, therefore, of an isthmus of dentine between the outer and inner cusps considerably increases the stability of the tooth. It is also a good plan to cut away the inner cusp and extend the filling over it. In the case of approximal cavities to be filled with cohesive gold, the filling is started by wedging a piece of gold into a pit or groove. The latter is generally preferred, and consists of a small groove, slightly undercut, in the cervical wall of the cavity. In a few cavities the older method of "*starting pits*" will be found useful. These pits are made as follows: The drill is buried to such a depth that the head is just below the level of that part of the cavity where the pit is to be made, and the head is then moved with a slight rotary

motion; the result is a small cavity (fig. 518). If the drill head is rotated when only half buried, a cup-shaped cavity will be produced, and this is useless (fig 519). Starting pits should always be drilled in the dentine itself. If drilled at the junction of the enamel and dentine, one wall will be formed of enamel, which leads to fracture during filling. The direction of starting pits should be as far away from the pulp as possible.

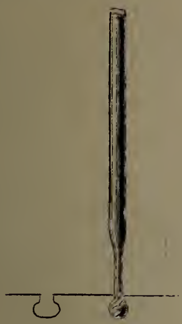

Fig. 518.

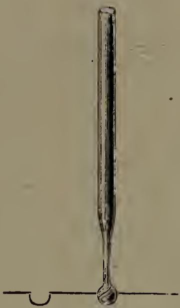

Fig. 519.

The advantage of shaping approximal cavities like a double wedge for cohesive gold is that all parts are easily accessible and filling is thus more satisfactorily carried out.

Small approximal cavities in molars and premolars situated near the gum may be approached from the labial or buccal walls, instead

Fig. 520.—Showing approximal cavity in a mandibular premolar opened up from the labial wall.

of opening up from the crown which entails the loss of much sound tissue (fig. 520). The retentive shaping of the cavity is carried out as described above. In these cavities the lingual wall forms the base. This method of treating approximal cavities is adopted when the caries is situated in the root of the tooth, as seen in patients with "recession of the gums." One disadvantage of this method is the difficulty of producing self-cleansing edges.

Of approximal cavities in the anterior teeth the smallest are often the most difficult to fill. A good separation of the teeth is needful, as with more space available for the preparation of cavities less tissue is sacrificed in retentive shaping. In small cavities for which non-cohesive gold is intended, the preparation is similar to that for simple cavities—namely, walls slightly divergent. For cohesive gold, small cavities are to be prepared as follows: With a fine finishing bur the anterior wall is cut so that it slopes outwards and can be easily seen, a starting pit being made at the cervical margin, and an opposing point below for retention of the filling. With larger cavities an approach should be made from the lingual aspect, the labial wall being saved as much as possible. The shaping of the cavity will then be somewhat like that of approximal cavities in premolars and molars, retention being obtained by a slight groove in the cervical wall, opposed by a small groove or pit, according to the amount of tissue available (fig. 521).

Fig. 521.

Fig. 522.[1]

When the cavity involves a large portion of the side of the tooth, the labial and lingual walls must both be freed from all frail enamel and a different mode of procedure adopted in shaping it. *The labial and lingual walls should not be grooved.* In the cervical wall a groove should be made, and opposed by a good-sized pit drilled towards the apex of the cavity. In many cases, the incisive portion of the cavity cannot with safety support an anchorage, but if the cavity is extended in the manner shown in fig. 522, an excellent hold will be obtained.

Cavities for plastic fillings should be prepared in a manner slightly different from those prepared for gold. The enamel margins on the occluding surface should be straight and not bevelled, as the thin layer of enamel thus left is less likely to fracture than the feather edge of plastic material.

---

[1] From Kirk's "Operative Dentistry."

(*b*) Hypersensitive Dentine

The preparation of cavities for filling is at times hampered by hypersensitive dentine. The area of hypersensitive dentine frequently varies, one portion of the tooth being distinctly more painful than another. The portions of dentine immediately beneath the enamel and at the neck of the tooth are usually the most sensitive.

The pain can, however, be greatly alleviated by keeping the cavity dry during excavation, and by using sharp instruments with a decided cutting and not scraping action.

Treatment:—

Dehydration.—The application of hot air in the form of blasts from a suitable syringe greatly reduces this sensitiveness of the tooth substance. The hot air may cause a little pain, but if it is applied with tact and care pain can usually be avoided. The hot air dehydrates the dentine. If absolute alcohol is applied before the hot air, the dehydration is increased, but the treatment is more painful.

Carbolic Acid.—Strong carbolic acid allowed to remain in the cavity for a few minutes and the dentine dried with hot air. This remedy is not very efficient if a result is desired at once, but if carbolic acid is sealed in the cavity for two or three days a decided obtunding of the dentine is obtained.

Zinc Chloride.—Chloride of zinc is a powerful coagulant and must be used with caution when the pulp is near. The cavity must be isolated and a small piece of chloride of zinc in the solid state allowed to dissolve. The application causes pain, but the pain rapidly passes away.

Nitrate of Silver.—This drug causes unsightly discoloration and can only be applied to the posterior teeth. It is slow in its action. In superficial cavities, the nitrate of silver is applied in the form of a fine powder on a piece of cotton-wool slightly moistened, or the drug in a solid state may be rubbed over the sensitive surface. The tooth is then left for one or two days, when the dentine becomes less sensitive. In deeper cavities, a little of the fine powder may be sealed in with gutta-percha.

Where it is intended to use metal fillings and the dentine is sensitive, the best course is to insert an oxy-phosphate filling and allow it to remain for about six months. In some instances, the tooth substance is so sensitive that it is almost impossible to remove any of the carious tissue. A filling of oxy-sulphate of zinc, if left in place for one or two weeks, will allay the sensitiveness

sufficiently to allow of the preparation of the cavity. For posterior teeth which are very sensitive, the application of nitrate of silver may be substituted for the oxy-sulphate.

Preparations containing formalin give good results, but they must be used with care, as formalin possesses great power of penetration and may endanger the vitality of the pulp.

(*c*) **The Use of Matrices**

The matrix is an indispensable instrument for making contour fillings. By the use of properly constructed matrices the entire crown of the tooth can be restored, thus obviating the use of crowns. A *simple matrix* may be made out of a piece of metal bent to the shape of the tooth and fixed in position by a wedge at the cervical margin. To R. P. Lennox belongs the credit of first

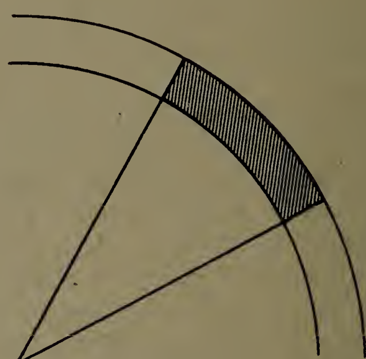

Fig. 523.

describing a rational method of constructing matrices which will conform well and closely to the tooth at both cervical and occlusal edges. A tooth tapers from the crown downwards and approximately resembles a cone; a matrix to fit correctly must taper in a similar way, and should therefore be the segment of a flattened ring of metal. It is found by calculation that the inner curve of the segment corresponds to a circle with a radius of $1\frac{13}{16}$ in. The ends of the matrices must correspond in direction to the radii of the ring (see fig. 523). It is found that matrices for molars and premolars can be cut from a similar curved segment, the difference being a variation in the length of the segment. In fitting matrices to roots which are grooved, for instance the anterior aspect of the first upper premolar, Lennox has suggested a neat contrivance in the form of a mandril, the ends of which correspond to the cones

formed by the matrices suitable for an average premolar and molar, respectively. Down the mandril, grooves are cut to correspond to the grooves in the teeth. The mandril is used as follows: The lip of the matrix having been inserted into the slot in a clamp, the matrix is slipped on to the mandril and, with a hammer, tapped into symmetrical shape.

Before withdrawing the matrix from the mandril the lower margin is forced into the groove. This seems to prevent the matrix, when applied, drawing away from the groove on the tooth. In practice, Lennox matrices answer admirably. Matrices must be firmly kept in position, and should fit accurately and tightly against the cervical margin. Plastics can easily be used, but, with gold, great care must be taken to bring the metal over the edges; indeed, it is extremely difficult to use matrices with cohesive gold. With amalgam fillings which have been contoured, great care must be exercised in removing the matrix, and generally it is better to allow the matrix to remain until the filling has hardened. Matrices should be made of thin but strong metal.

(*d*) The Use of Screws for Retaining Fillings

In places where it is not possible to shape the cavity to a "retentive" form, screws fixed into the dentine are useful. The

FIG. 524.

screw is also useful as a means of retention where cuts and grooves would endanger the pulp, or throw an extra strain on walls already weakened. The screws should possess fine threads varying from one hundred to about fifty to the inch, according to the size of screw used.

The location of the screw is of importance. If the pulp has been removed the screw should be inserted into the canal. With living pulps the screw must be inserted as far as possible from the pulp, yet not too near the enamel margin. For incisors and canines the linguo-cervical angle is better than the labial. For the molars and premolars it is advisable to fix the screw in the centre of the body of the tooth near the coronal surface.

When fixed in the pulp canals the screw must be large enough to obtain a firm grip—an important point which is often overlooked. The form shown in fig. 524 is useful. The end is tapered and the screw steadily inserted.

The root is apt to be split by a screw if too much force is used. When a firm grip has been obtained, the excess portion of the screw is cut off with a pair of sharp pliers. Screws should project well into the cavity. For teeth with living pulps, the form shown in fig. 525 or fig. 526 may be used. A small hole is drilled in the dentine with a suitable instrument, and the screw gradually inserted.

(*e*) The Materials Used for Filling Teeth

The materials used for filling teeth are gold, tin, amalgam, osteo-plastics, gutta-percha, and porcelain. Solutions of gum resins are employed in conjunction with cotton-wool as temporary measures. *An ideal filling* should be hard enough to resist attrition; capable of withstanding any chemical action of the mouth; a non-irritant; a non-conductor and easy of adaptation; it should retain its shape after insertion and, in colour, should resemble the natural tooth. At present no filling in general use

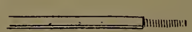

Fig. 525.

Fig. 526.

fulfils all these conditions, and for any given case a selection has to be made of the most suitable material available.

(i) Gold.—Two forms are used, viz., *the cohesive and the non-cohesive preparations.*

In the cohesive method, each piece of gold is made to cohere to that already in place, and should not move in the slightest degree after it has once been placed in position. *In the non-cohesive method*, the portions of the filling are held together by being closely interlaced and wedged against each other and over one another.

Each method has its special advocates. Those who favour non-cohesive gold claim that it adapts itself to the walls of the cavity better than cohesive gold, and can be worked quicker; while those who favour cohesive gold assert that, although it takes longer to work, it makes a harder filling; adapts itself to the cavity walls quite as well as non-cohesive gold, provided that the cavity is properly prepared, and, for approximal cavities, possesses the additional advantage of being able to withstand the force of mastication.

Generally it may be said that non-cohesive gold is better for

crown cavities and the cervical one-third of approximal cavities in molars, premolars and anterior teeth, and that cohesive gold is more serviceable when any contouring is necessary or any strain is likely to be thrown upon the filling.

In recent years gold as a filling material has been largely superseded by amalgam for the posterior teeth and by porcelain for the anterior teeth. The substitution of amalgam for gold for the posterior teeth has been brought about by the improvements made in the construction of amalgam, an amalgam filling now being almost as efficient as a gold filling. Amalgam also possesses a distinct advantage in being more easily contoured than gold, and, in finishing, there is less likelihood of injuring the soft tissues at the neck of the tooth—a point of considerable importance in relation to periodontal disease. Porcelain fillings for the anterior teeth have supplanted gold fillings for æsthetic reasons, but porcelain is not so reliable as gold.

The advantages of gold as a filling are (*a*) that it retains its shape, and constitutes practically a water-tight plug, and (*b*) that it withstands attrition. In using gold it should be remembered that it has no preservative action whatever upon the tooth substance.

(ii) Tin.—Tin is generally used in combination with gold; it is seldom employed as a filling by itself. The advantages claimed for it are that (*a*) it is easy to work and (*b*) it has a preservative action upon the tooth substance. The latter quality makes it useful as a lining to cavities and at cervical margins. It has one distinct disadvantage, it becomes black.

(iii) Plastic Fillings.

(*a*) **Amalgam.**—An amalgam is an alloy of which one constituent is mercury. The amalgams used in dental practice consist of the combination of the mercury with a single metal, as in palladium, copper and silver amalgams, or with alloys of two or more metals. Amalgam has a much greater range of usefulness than any other filling, but it possesses two important disadvantages, viz. :—

(*a*) Liability to become discoloured—principally through the formation of sulphides from the action of sulphuretted hydrogen in the mouth.

(*b*) Tendency to alter its shape and to fracture at the edges.

Both these drawbacks may be overcome to some extent by :—

(i) Special attention to the composition and manufacture of the alloy.

(ii) Attention to the preparation of the cavity.

(iii) The method of inserting the filling.

Viewed by the light of present knowledge, it appears that the basis of the alloy should be composed of silver and tin, with the addition of gold and zinc or copper when the amalgam is not to be used in a position likely to be seen. In addition, it is important that the utmost care be taken in casting, cutting and annealing the alloy.

The following is the formula of a good working amalgam[1]:—

Silver	69·5 parts.
Tin	25·5 ,,
Gold	4·0 ,,
Zinc	1·0 ,,

The preparation of cavities for amalgam fillings differs only slightly from that required for gold fillings. Amalgam being a plastic material, it is not so important that there should be direct access to all parts of the cavity. The edges should be left straight, and not bevelled, as the thin layer of enamel is less liable to fracture than the thin ledge of amalgam which would be present if the edges were bevelled. The student must remember that the preparation of cavities for the insertion of amalgam fillings requires as much care and attention as gold work. Too frequently amalgam fillings are made in a careless manner.

Galvanic Action from Amalgam Fillings.—The occlusion of teeth containing amalgam and gold fillings will start galvanic action under certain conditions.

The following are examples from practice: An amalgam filling was inserted in a left second molar which occluded with a gold crown. Two days afterwards the patient complained of distinct pain whenever the amalgam and crown were brought into contact, and expressed the opinion that the pain was due to electrical action. The whole of the surface of the amalgam filling, which occluded with the gold, was cut out and filled with a non-conducting filling (oxy-phosphate), and the pain ceased. In another case a biting-block of gold occluded with an amalgam filling. The tooth was not painful to heat or cold, but pain was felt every time it was brought into contact with the gold biting-block.

(β) Osteoplastics.

(i) *Oxy-chlorides.*—The powder consists of zinc oxide which has been heated almost to whiteness for about two hours, during which time it loses half its bulk. Borax and silica are often mixed with it with a view to increase its hardness. Oxide of zinc often contains arsenic as an impurity, but it is not probable that arsenic is ever

[1] For the various formulæ of fillings I am indebted to Andrew Kelly.

present in sufficient quantity to exert any deleterious effect. The fluid is a solution of zinc chloride in water in the proportion of four to three. Oxy-chloride of zinc does not form a permanent filling, as it is acted upon by fluids of the mouth, especially at the cervical margin. It is also of little use in places where there is much attrition. It is hygroscopic, sets quickly, is an irritant and an antiseptic. Oxy-chloride is principally employed as a root filling and as an obtundent for sensitive dentine.

(ii) *Oxy-phosphates.*—The powder is made of oxide of zinc. The oxides of magnesium and aluminium are sometimes added with the view of accelerating the setting. The various shades of colour are produced by colouring matters, which probably lessen the resistance of the filling to solvents. The fluid is principally composed of phosphoric acid, zinc oxide and water.

As a filling the oxy-phosphate is more permanent than the oxy-chloride. It is soluble in the alkaline secretions of the mouth. It is antiseptic, though not so marked as the chloride, and, like the latter, it may lead to death of the pulp if used in too close proximity to that organ. Oxy-phosphate fillings last, on the average, about two years, though they may continue serviceable for seven years, and in rare instances longer.

The use of oxy-phosphate is indicated—

(1) As a flooring in crown cavities (when not too near the pulp).

(2) As a root filling.

(3) As a lining to cavities with frail walls.

(4) In cavities which are sensitive, and in which it is desired to insert a metal filling—an oxy-phosphate filling allowed to remain for a period of three to six months will act as an obtundent.

(5) In front teeth of weak structure.

(6) In combination with amalgam.

(7) For the fixation of crowns and porcelain inlays.

It should not be used in cavities which cannot be kept absolutely free from moisture during filling.

(iii) *Oxy-sulphate.*—The powder is composed of a mixture of calcined sulphate of zinc and oxide of zinc. The fluid is a solution of gum arabic.

The following is a useful formula:—

Powder:	Zinc oxide ...	82 parts.	*Fluid:* 20 per cent. solution of gum acacia, to which a suitable preservative may be added.
	Zinc sulphate ...	11 ,,	
	Mastic	7 ,,	

Oxy-sulphate is extremely useful:—

(1) As a flooring to sensitive cavities near the pulp.

(2) For covering exposed pulps (in combination with a sedative).

(3) For very sensitive cavities. A filling of oxy-sulphate used for one or two weeks will allay the sensitiveness.

(iv) *Oxy-phosphate of copper* has been introduced by Ames, and is most valuable for the fixation of splints in the treatment of fractured jaws.

(γ) **Translucent Cements.**—During the last few years translucent cements have been extensively used as fillings.

It is too early to express a definite opinion as to the value of translucent cements, but there seems little doubt that with improvements in their composition and a better knowledge of their behaviour they will be found most valuable fillings. Translucent cements are not adhesive, and it is necessary therefore that the cavity should be cut to retain the filling as in the case of gold and amalgam. There is a tendency for the translucent cement to cause death of the pulp, and it is advisable therefore that cavities should be lined with an oxy-phosphate or an oxy-sulphate cement. Their use is indicated for æsthetic purposes in cavities in the anterior teeth. They should not be used on occluding surfaces, or for the appromixal cavities in premolars and molars, as in these places amalgams or gold are more serviceable and reliable.

(δ) **Gutta-percha.**—Gutta-percha is the inspissated juice of *Isonandra gutta* and other trees of the natural order *Sapotaceæ*, According to Baumhauer, the chief constituent of gutta-percha is a hydrocarbon having the composition $C_{10}H_{16}$, identical with the *gutta* of Payen; the other constituents, alban $C_{20}H_{32}O_2$, and fluavil $C_{27}H_{32}O$, being probably products of oxidation. Gutta-percha is insoluble in alcohol, slightly soluble in ether, benzol, and oil of turpentine, freely soluble in chloroform and carbon disulphide. For dental purposes it is generally combined with zinc oxide and silica, with or without some colouring matter. The resins appear to lower the softening point, increase the time of setting, and considerably diminish the tensile strength.

Gutta-percha deteriorates from exposure to air and light, more especially the latter. The deterioration depends greatly upon the quality of the gutta-percha. A good gutta-percha filling should be tough, should soften at a temperature not more than 175° F., and should set in from thirty to forty-five minutes. It should be "sticky" in working. The filling material is best preserved in the form of sticks wrapped in tin-foil and kept in a box, pieces being cut off as required. The following formula is recommended by W. Rushton[1]:—

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[1] *Trans. Odonto. Soc.*, 1898, p. 120.

Pure gutta	50 parts.
Finely levigated silica	30 ,,
Oxide of zinc	20 ,,

The gutta should be gradually heated and the powders added in small quantities at a time.

The following is a useful type of temporary gutta-percha:—

Gutta-percha	18 parts.
Hard paraffin	9 ,,
Calcium sulphate	26 ,,
Oxide of zinc	47 ,,

Properties.—As a filling, gutta-percha is a perfect non-conductor, and, though it does not make a water-tight filling, fresh caries seldom seems to occur from this defect. In dirty mouths, it discolours, becoming yellowish in appearance. If inserted too near the pulp, it frequently leads to the destruction of that organ. Cavities in which gutta-percha is temporarily placed often appear to be more sensitive on the removal of that material than before its insertion, which seems to show that gutta-percha increases the sensitiveness of dentine.

Indications for Use.—Gutta-percha should not be used upon a masticating surface, as it bears attrition badly. Gutta-percha, though principally used as a temporary filling, is occasionally of great use permanently, the principal cases in which its use is indicated being:—

(1) The anterior teeth of young children, as the saliva in children seems to dissolve osteoplastics very quickly.

(2) In certain cavities on the buccal and labial surfaces of teeth.

(3) For filling root canals.

(4) As a temporary filling where it is necessary to wedge the teeth for the purpose of separation before the introduction of a permanent filling.

(ε) **The Solution of various Resins.**—Gum mastic and gum sandarac are used as temporary fillings. They harden through the resin being precipitated by the saliva and the evaporation of the solvent ether, chloroform, &c.

(ζ) **Porcelain Inlays.**—During the last few years, porcelain inlays as fillings have claimed a large amount of attention. They possess the advantage of more nearly resembling the appearance of the tooth than any other filling, and are therefore extremely useful for cavities on exposed surfaces. They are fixed in position with oxy-phosphate cement. In estimating the usefulness of this filling, it must be remembered that oxy-phosphate cement is acted

upon by the saliva and that the layer of cement between the inlay and the tooth substance must be regarded as a vulnerable point. In durability, porcelain inlays are inferior to gold and amalgam, but they are superior to gutta-percha and osteoplastics. During recent years they have been almost entirely superseded by the translucent cements.

Methods of Preparation.

(i) *The Rotation Method.*—To Storer How of Philadelphia belongs, it is believed, the credit of introducing this system of inlaying.

The cavity in the tooth is gradually enlarged and made circular in outline, but slightly tapering towards the base. Fine cut burs are needed, and the drilling must be done with a delicate but firm touch, in order that the cavity be truly circular. A rod of porcelain of the right colour and approximate size is selected, a disc is cut off and fastened by means of shellac to a mandril rotated by the engine. With carborundum wheels the porcelain is accurately fitted to the cavity; the disc, when lying in the cavity, should project slightly beyond the surface of the tooth. The inlay is fixed with some form of oxy-phosphate mixed thin. When the cement is hard, the inlay is ground flush with the surface of the tooth and finally polished with an Arkansas stone and a little putty powder. The finishing is better carried out at a subsequent visit. The final fitting may be done by wetting the inlay with fine polishing paste and rotating it in the cavity. Care must, however, be exercised, as the disc is liable to stick fast and injure the enamel margins. Some operators prefer to cut the inlay from an artificial tooth, and, so far as colour is concerned, a more satisfactory result can be obtained in this way. The disadvantage of the rotation method is the needless sacrifice of the sound tissue in many cases. Messrs. Claudius Ash, Sons and Co. have prepared a series of circular inlays of various colours corresponding in size to fine-cut burs, and by this system the process of inlaying is considerably accelerated.

Irregularly Shaped Inlays.—*The cavity* must be formed without undercuts and in such a way as to counteract the lines of greatest pressure. For example, in the large inlays in the upper incisor teeth the main strains on the inlay are upwards from the occlusal surface and outwards from the palatine. The upper strain may, to a certain extent, be neutralized by preparing the cervical portion of the cavity, and the outward strain by cutting away the palatine wall so that the labial wall extends beyond it and takes the outward strain (see diagram, fig. 527).

The Matrix.—The matrix may be made from gold foil No. 40 or platinum ($\frac{1}{2000}$ in). A piece of suitable size and shape is selected, and two or three small nicks made in it. The foil is then placed over the cavity and gently pressed home with a piece of amadou, and an impression of the cavity obtained. The foil is then bent over the edges, and burnished so as to secure a sharp and exact mark of the edges. It is an advantage to melt a little wax into the matrix before removing it from the tooth. By this means, the liability to crumple the matrix is overcome. With a suitable instrument, the matrix is enticed out of the cavity and immediately invested in a mixture of silex and plaster.

Many operators prefer to take an *impression of the cavity*, and for this purpose generally use either gutta-percha or dental lac. From this impression a mould in oxy-phosphate of copper cement is made and a matrix of thick platinum ($\frac{1}{1000}$ in.) fitted either by hand or by means of a small swager.

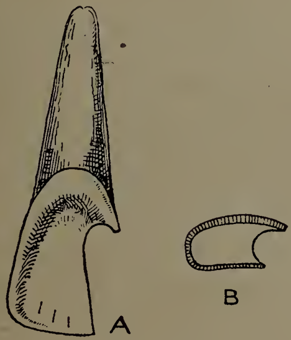

Fig. 527.

The inlay may be made of a low- or high-fusing body. The former is suitable for small cavities requiring but little contour, the latter for larger inlays. High-fusing bodies make stronger inlays and present a more natural appearance. Inlays made in this way are composed of three bodies:—

(1) The foundation, melting at 2,300° F., corresponding to the dentine.

(2) The high-fusing, melting at 2,150° F., corresponding to the enamel.

(3) The medium-fusing, melting at 2,000° F., corresponding to the surface.

The temperature is gauged either by a pyrometer, or pellets of gold alloy, which fuse at different degrees of heat. The body should

be mixed into a stiff paste with distilled water, the various stages being as follows:—

(1) The foundation body is packed into the matrix, and with a suitable instrument a cross + is made. The object of the cross is to cause the body when fused to tend to separate into four small masses rather than to consist of one large mass in the centre. After fusing, the matrix with the body is replaced in the mould and the edges of the matrix again burnished over the edges of the cavity. When the matrix has been made direct from the cavity, although this step is not necessary, there is more certainty of a good result if the matrix is again introduced into the cavity and burnished into place, and then invested again.

(2) The high-fusing body is now added and built up to the necessary contour, and the inlay fused again. This operation is repeated until the inlay has assumed the form desired.

(3) A thin layer of the medium-fusing body is then added, and the inlay finished.

When the inlay is made, it should be grooved and the cavity slightly undercut, oxy-phosphate cement being used for fixing.

Some experience is necessary in choosing the shade of colour for inlays, as the inlay when inserted often appears altered in colour. Deep inlays yield more satisfactory results than shallow ones, as the cement is not so likely to show through. Alteration in colour is due to the amount of light and the amount of reflection. The more perfect the front and side light, the less the variation. Labial inlays give good results, but in the case of approximal inlays light is shut off by the adjacent tooth and the colour is affected, the inlay then appearing to be of a darker shade.

(η) **Gold Inlays.**—Inlays made of cast gold are advocated by some operators for use in approximal and crown cavities in the posterior teeth, the inlays being fixed into position by means of oxy-phosphate cement. It is difficult to see that these inlays have any advantage over properly constructed amalgam fillings. With the latter, retention is obtained by means of undercuts—a much more reliable and rational method than by trusting to the adhesiveness of osteoplastics. With amalgam, good edges can be obtained and the filling more easily brought to the proper contour.

(*f*) Introduction of Filling Materials

(i) Gold.

(a) The method of using cohesive gold.

(β) The method of using non-cohesive gold.

(γ) Combination of the cohesive and non-cohesive methods.

(δ) Gold in combination with other metals.

(*a*) **The Cohesive Method.**—This method is more often adopted than any other. The gold is consolidated either by hand pressure or by mallet force; that is, the force given to the plugger is either direct from the operator's hand or by means of a mallet which may be used by hand or by some mechanical contrivance.

Two forms of gold are usually employed, viz., tape and pellets. *The tape* is usually made by folding sheet gold to the required thickness, but the gold can be purchased ready folded. A sheet of gold measures 4 in. square, and the foils are generally numbered according to the weight of the sheet; thus a sheet weighing 4 gr. is termed No. 4 thickness, and a sheet weighing 8 gr. is termed No. 8 thickness. Gold tape is also numbered according to the weight of the sheet, thus "48 tape" is tape which weighs 48 gr. per sheet of 4 in. square. The tape generally used is from 32 onwards. To obtain these thicknesses it is usual to fold thinner foil. Thus, No. 4 foil folded once makes No. 8, folded twice makes No. 16, and three folds make No. 32. Two or three sheets can be folded at once when greater thicknesses are required.

Heavy or rolled gold of thickness averaging from 20 to 60 is sometimes used instead of folded thin foils. This form is extremely cohesive and useful for contouring, but it is not so easily worked and does not adapt itself to the cavity so well as tape prepared by folding. For folding gold, a pad and a foil knife are required. The edge of the foil knife must be perfectly straight.

When the gold has been folded the next step is to cut it into strips, and an easy method of cutting it quickly and evenly is as follows: Take the folded gold in a pair of tweezers held between the thumb and first and second fingers of the left hand, then take the foil scissors in the right hand, resting the lower blade on the third and fourth fingers of the left hand; by this means the scissors are steadied and the gold may be cut to any width desired.

The thickness of gold used varies; for retaining pits and difficult cavities, No. 32, for more accessible places Nos. 48, 64, 96. To obtain dexterity with the heavier foils considerable practice is required. The width of strips also varies; for retaining pits they may be practically as fine as can be cut ; for difficult cavities , and for more accessible places, according to the breadth of the cavity.

The foil may be used in the form of *rope*. The other form of cohesive gold, viz., *pellets*, requires but short notice. There are numerous makes in various shapes; the cylinders are the most useful form. As regards the merits of tape versus pellets consider-

able difference of opinion prevails. Tape is probably the better, especially for building over edges and contouring. Those who use pellets claim that they are more easily and more quickly worked. In some cases pellets may be more easy to work in the early stages of the filling, but it is very questionable whether they can be worked more rapidly than tape, seeing that foil of 64 thickness onwards can be manipulated with the engine mallet. Moisture, grease and exposure to air destroy the cohesiveness of gold, and care should be taken to avoid contact with the hands. Though foils are sold as cohesive, it is always best to anneal them before use. Annealing is usually accomplished by passing the gold through an alcohol flame. The alcohol must be quite pure. The safest method to avoid possible impurities from the flame is to place the gold in a tray of mica or platinum and heat it over the flame, or an electric heater may be used.

In annealing, avoid overheating the gold, as many kinds become harsh when exposed to a high temperature. Good cohesive gold can be annealed to a dull red heat without becoming harsh.

For **starting cohesive cavities,** two principal methods are in vogue, viz., starting pits and grooves.

Starting pits are seldom used now except in shallow cavities.

For facility of description, the *filling of cavities will be considered under three main heads*, viz. (i) crown cavities, (ii) approximal cavities in molars and premolars, (iii) approximal contour cavities in front teeth.

(i) Crown Cavities.—These cavities are typical in molars. They are best started with cylinders or rope, as follows: Take two or three large cylinders, according to the size of the cavity, and, with a suitable plugger, tuck them round the margins of the cavity, leaving the centre. This operation only slightly condenses the cylinders, but the gold is in a convenient position for working. Steady the cylinders with a plugger held in the left hand, and by firm pressure, first round the edges towards the walls, and then in the centre, condense the gold closely. It is very useful to condense a strip of cohesive tape with the cylinders, as it will enable the operator to start his cohesive foil more easily.

The cylinders being steady, anneal a piece of tape by passing it through the spirit flame, keeping the part between the tweezers in the flame a little longer than the rest, place the gold in the cavity and condense with suitable pluggers, using either hand pressure or mallet force. In condensing, fold the gold over so that each fold lies parallel with the floor, and exert the force in a direction as far as possible towards the walls of the cavity.

The piece being in position fresh portions are added and thoroughly condensed until the cavity is full.

In malleting, the force of the blow should be directed towards the walls of the cavity, the most inacessible parts being filled first, and the filling kept a little higher towards the walls than in the centre. It is impossible to build the gold so accurately as to bring it exactly flush with the edges of the cavity, hence it becomes necessary to mallet the gold over the edge, and, when the plug is completed, to cut down the surplus by means of burs and carborundum points.

The most important, and at the same time the most difficult part of a filling to execute with accuracy and nicety is the operation of **building over the edges.** It can be accomplished as follows: Tuck down a strip of gold near the margin of the filling, and, having carried the tape over the edge, refix it again over the same

Fig. 528.—Showing loop hanging down.

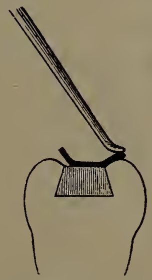

Fig. 529.—Showing loop malleted down.

spot (fig. 528). A loop of gold is thus left hanging over the edge; first tap this loop down gently and then mallet, taking care not to use too much force (fig. 529). Having built over all the edges and filled up the centre of the cavity to the right level, the next step will be to trim the filling by cutting down the surplus over the edges, smoothing the surface and polishing. For this purpose finishing burs and stones are used, the former for cutting away the surplus over the edges, the latter for smoothing the surface. In using these, care should be taken to cut in a direction from the filling to the tooth, rather than from the tooth to the filling, because in the former case one is likely to burnish the gold over the edges, in the latter to tear the gold away from the edges. When the edges have been trimmed, attention should be turned to the bite, care being taken that the filling is not high (a most important point). When it has been ascertained that the bite is not obstructed, the

surface should be smoothed first with a carborundum and then with an Arkansas or Hindustani stone, the object of the latter being to remove scratches and so produce a higher finish; finally, complete the operation with some pumice on either a wooden or rubber point. The various steps in filling a molar are diagrammatically illustrated in figs. 530 to 535.

Fig. 530.—Showing the filling started by wedging cylinders into the base of the cavity.

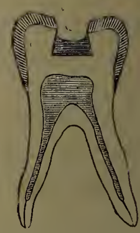

Fig. 531.—Showing how to fill the cavity, keeping the gold a little higher against the walls than in the centre.

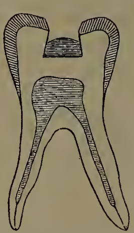

Fig. 532.—Showing how not to fill the cavity, "not to keep the gold higher in centre than at the sides."

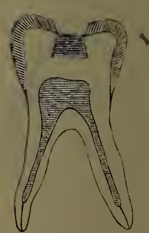

Fig. 533.—Showing the time to build over edges.

Fig. 534.—Showing the cavity filled ready for trimming.

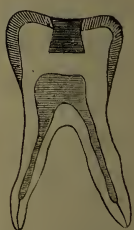

Fig. 535.—Showing the filling completed.

In trimming the edges, the joint between the enamel and the gold should not be considered perfect until the finest probe passed from the filling to the tooth, or *vice versa*, does not catch, the edges being considered trimmed when the probe passes over all the parts without catching.

(ii) Approximal Cavities in Premolars and Molars.—These cavities are best started from a groove in the cervical wall. A piece of gold is annealed, placed in the groove and gently pressed into position. One end of the gold is thoroughly condensed, while the other end is held firmly with an instrument. The condensed portion is then kept firmly pressed into place, while the remainder of the gold is condensed. It is most important that the gold in the groove should be steady. If retaining pits are used, they should be filled as follows:—

To anneal a strip of gold: It sometimes happens that the end held by the tweezers does not get thoroughly annealed, and to avoid this contingency the strip of gold should be held by one end, and, when sufficiently heated, should be taken up by the other end and again passed through the flame.

When the strip is annealed, gently lay it over the orifice of the pit by means of the tweezers, and with a fine-pointed plugger invaginate the gold into the pit. In removing the instrument, give it the slightest amount of rotation as this will prevent its bringing out the gold. The gold is now firmly tucked in, in successive folds, until the cavity is full.

It is essential that a firm pressure should be maintained throughout the operation of filling. The plugger used should be less in circumference than the pit, otherwise the gold will be cut in the act of filling.

The pits being filled, a bridge of gold is made from one to the other, and the foil condensed in layers parallel to the floor. The next step is to build from this bridge in a direction towards the cervical edge, using exactly the same methods as described under "*crown cavities*," and having looped the foil over the edge, it is an excellent plan to chop off with the mallet (engine or hand) any superfluous material—this is equivalent to burnishing the gold against the edge. Too much care cannot be bestowed on this part of the cervical edge, as it is the most important part of the filling.

This operation having been satisfactorily completed, fresh pieces of foil should be added until the cavity is full, care being taken to keep the gold flat, and, if anything, a little higher against the walls than in the centre, and a little higher on the contour surface than towards the median line of the tooth. The edges are built over as the cavity fills, the crown surface and edges being completed last.

In filling these cavities, build out the contour so as to carry out the principles enunciated on p. 579. The finishing of these fillings is accomplished as follows:—

The cervical edge and upper part of the plug are first roughly

trimmed down with plug trimmers, care being taken to use these instruments so as to cut in a direction from the gold to the tooth substance, for the reasons previously stated. Strips of emery tape are used for finishing. The lateral margins can be trimmed with discs, but, in finishing, care must be taken not to destroy the "contour." To make sure that the cervical edge is thoroughly finished, it is necessary, as in the case of crown cavities, to test with probes, and, wherever a catch is discovered, the tape and plug trimmers must be again brought into use.

Fig. 536.—Showing gold bridged between retaining points, or groove filled.

Fig. 537.—Showing gold built over cervical edge.

Fig. 538.—Showing how to build, keeping the gold a little higher against the sides than in the centre.

If discs are used to finish the cervical margin, a depression is very likely to occur, and is indeed difficult to prevent. The occluding surface is trimmed in exactly the same way as in crown cavities. The contour surface is polished with either a little pumice on ordinary sewing tape, or with rubber cups or discs on the engine. Figs. 536 to 540 represent the various stages and steps above described.

(iii) Approximal Fillings in Anterior Teeth.—In these cavities great care must be taken to get the gold into absolute contact with the front wall of enamel in order to avoid that bluish-black appearance sometimes seen in front teeth filled with gold. In filling, the

method of procedure should be as follows: First, fill the retaining pits or grooves in the cervical wall and build over the cervical edge as recommended above. Next, build the filling down a little way, contouring to the required shape and taking special care that the

FIG. 539.—Showing cavity full.

FIG. 540.—Showing the filling trimmed and completed.

FIG. 541.—Showing side and front view of cavity.

FIG. 542.—Showing retaining points filled and bridged between.

FIG. 543.—Showing filling built down slightly and contoured.

FIG. 544.—Showing actual cavity filled in.

filling is well against the posterior wall (see fig. 543). Now, finish filling in the actual cavity, paying particular attention to the opposing point. (This stage is represented in fig. 544.) Next, build over the posterior wall and edge, carrying the filling out to the

required contour (fig. 545), and, this accomplished, fill the tooth in, first building over the anterior edge and out to the required shape. Building over the posterior edge first is recommended principally because the tendency is for the operator to build the filling out to the contour of the tooth in front, leaving the posterior wall, which is exceedingly difficult of access when the filling is completed in front.

These fillings are best finished with plug trimmers and tape at the cervical edge, discs and tapes for the approximal surface, small carborundum wheels for trimming the anterior surface, oval finishing burs, and small carborundum wheels for the posterior surface. Pumice or rubber points, or ordinary sewing tape, should be used for polishing.

Fig. 545.—Showing posterior wall built over.

Fig. 546.—Showing filling completed.

Figs. 541 to 546 represent the various stages and steps above described.

The foregoing description must be regarded as a synopsis of the usual order of procedure, and not as an attempt to explain in detail the filling of cavities. There are, of course, many other shapes of cavities besides those described, but the method is practically the same in each, viz.: (1) To start filling from grooves or retaining pits when these are present; (2) to build over the cervical edge; (3) to build the filling up as level as possible, keeping it, if anything, a little higher against the walls than in the centre of the cavity; (4) to build over the edge as the filling advances; (5) to fill the most inaccessible parts of the cavity first.

(β) **Non-cohesive Method.**—For this method, as with the cohesive, the gold is usually prepared in the form of cylinders. One of the most serviceable makes is that known as Ash's non-cohesive Style C.

There is one golden rule to be observed in the use of non-cohesive

gold, viz., that *the cylinders must be placed parallel to the walls of the cavity.*

Non-cohesive gold cylinders should be introduced as follows:—

Take three, four, or more (the number depending upon the breadth of the cavity) between the blades of the conveying forceps and, compressing them laterally, place them in position towards the posterior part of the cavity (fig. 547), holding them in place with an instrument in the left hand; condense them first on one side, then on the other, and finally in the centre. Continue to introduce and condense fresh rows of cylinders until the cavity is a little over two-thirds full (fig. 548). A different mode must now

Fig. 547.

Fig. 548.

be adopted. The cylinders should be placed round the side of that part of the cavity which is still unfilled, and condensed by wedging from the centre (fig. 549), the last portion of the filling being intro-

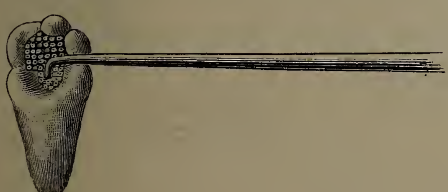

Fig. 549.

Fig. 550.

duced in the form of tape. The surface is then condensed and the plug treated in exactly the same way as described under the tape method (fig. 550). The rows of cylinders introduced first are very often difficult to keep steady for condensing, and when this is the case it is best to add a second or even a third row before condensing is commenced.

Non-cohesive gold can be most advantageously employed in crown cavities and in the upper portion of interstitial cavities in combination with cohesive. The advantages claimed for non-cohesive gold are that it adapts itself better to the walls of the cavity than cohesive, and that it is more quickly worked—a point of great importance in practice.

(γ) **Combination of Cohesive and Non-cohesive Methods.**—The combination of cohesive and non-cohesive gold is a very favourite plan with many operators. Cavities in *approximal surfaces of premolars and molars* are those usually filled by this method, the mode of procedure being as follows:—

Take two or three non-cohesive cylinders, according to the breadth of the cavity, and place them along the cervical wall so that the ends project outwards, not downwards. Condense gently so as to get them steady, and then add another row. Condense again, first on one side, then on the other, and finally in the middle. This process will prevent the gold from tilting. The procedure is continued until the cavity is about one-third full (fig. 551) when the cohesive gold is started by wedging up a large uncondensed cohesive cylinder; tape is attached to the cohesive cylinder and the filling completed in the manner described under the cohesive method, the plug being finished in the usual way (fig. 552).

Fig. 551.—Showing non-cohesive cylinders in position.

Fig. 552.—Showing the cavity completed, the light part being the non-cohesive, the dark part the cohesive portions.

The advantage claimed by those who advocate a combination of the methods is that a better joint at the cervical edge is obtained than with cohesive gold alone, while those who oppose the combined methods maintain that the non-cohesive gold is forced out by the power of mastication and forms a ledge for the lodgment of food, &c., at the cervical edge. This objection only holds good if too much non-cohesive gold is used. A useful mode of starting the cohesive gold is as follows: Before placing the last row of non-cohesive cylinders in position, insert a strip of tape as shown in fig. 553, then place the last row of non-cohesive cylinders, condense them and bring the ends of the cohesive strip across as shown in fig. 554.

In *approximal cavities in anterior teeth*, a combination of cohesive and non-cohesive gold will be found useful, especially in cavities

which do not involve much of the labial and lingual walls. In such cavities the cervical margins, lingual wall and portion towards the cutting margin can be filled with the non-cohesive, leaving only the portion towards the labial wall to be filled with cohesive (fig. 555). Operators skilled in the use of the non-cohesive gold method find no difficulty in filling such cavities entirely by that process.

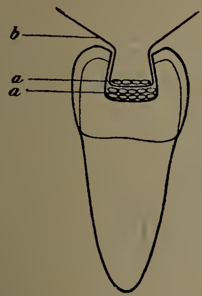

FIG. 553.—(*a*) non-cohesive cylinders; (*b*) strip of cohesive gold foil.

FIG. 554.—Strip of cohesive gold foil condensed over the non-cohesive cylinders.

(iii) Plastics.

(*a*) *Amalgam.*—There are many ways of inserting amalgam fillings, and, of these, three call for special mention.

Flagg, who was a great authority upon plastic fillings, objected to the method of burnishing in the separate portions, maintaining

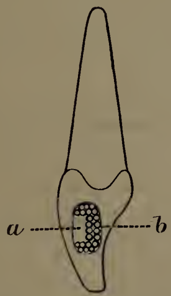

FIG. 555.—(*a*) cohesive; (*b*) non-cohesive.

that it was impossible to get union between successive pieces. He recommended that each piece should be worked into place with serrated pluggers, the force used being a succession of light blows.

Bonwill's method has many advocates. A small quantity of amalgam is introduced into the cavity, and over this a pad of

bibulous paper is placed and firmly pressed against the amalgam with suitable instruments, burnishers, tweezers, &c. The pad is then removed and is seen to contain a small quantity of mercury, while, at the same time, a large amount of mercury is also seen upon the surface of the filling. The mercury is removed, and another portion of amalgam inserted and treated in the same way, much pressure being used in its insertion. By these means the cavity is filled, great care being taken to remove the surplus mercury from the surface.

Kirby adopted the following plan, which yields excellent results: Two portions of amalgam are mixed, the first by taking equal parts by weight of mercury and filings. This is the soft mix; the second or dry mix is made by taking three times as much filings by weight as mercury. The first half or two-thirds of the cavity is filled with the soft amalgam which is worked into position with a burnisher without any undue pressure; the upper half or third of the cavity is then filled with the dry amalgam in much the same manner; the filling is then trimmed into shape. Kirby lays great stress upon having the smallest possible portion of mercury in the last part of the amalgam.

Kirby's method aims at obtaining an equal distribution of mercury throughout the filling, and he maintains that the change seen in amalgam is due to the fact that the mercury tends to disseminate equally throughout the filling, causing contraction in the part it goes from and expansion in the portion it goes to.

Matrices should always be used in approximal cavities, as it is extremely difficult without their use to insert good fillings in these situations. When the filling is inserted, the amalgam should be carefully trimmed, silk being used for the cervical edges and suitable burnishers for the other surfaces.

The Combination of Oxy-phosphate Cement with Amalgam.— Clinical experience shows that this combination leads to excellent results. The *modus operandi* is as follows: The cavity is thoroughly dried and lined with oxy-phosphate cement mixed fairly thin. A ball of amalgam is next inserted and pushed well home into the cement so that the whole surface is covered with a layer of amalgam. The cement is now allowed to set slightly and all surplus is very carefully trimmed away from the margins of the cavity, the remainder of the cavity being filled on the lines suggested by Kirby. In this way, fillings can be made which withstand the ink test. The osteoplastic seems in some way to lessen the alteration in shape of amalgam, besides which it is a non-conductor and prevents staining of the tooth substance.

Some operators combine the oxy-phosphate and amalgam as follows: The amalgam is mixed in the usual way, care being taken to avoid an excess of mercury; the osteoplastic is then mixed a little thinner than usual and the two thoroughly blended together, the filling being inserted like an ordinary osteoplastic filling. The amalgam in the mixture should vary between one-third to one-half of the whole bulk.

Mixing Amalgams.—In mixing amalgams, it is desirable to ascertain the proportion of mercury to filings which is necessary to produce a mass of a certain consistency. The required amount of mercury and filings should be weighed out and thoroughly incorporated by mixing in a mortar with a pestle.

(*b*) *Osteoplastics.*—For the insertion of these fillings it is important to exclude the saliva, and the rubber dam should therefore be applied whenever practicable. For mixing, a glass slab with square edges should be used; the spatula should be stout, quite flat and with square edges. The question of the consistency of the osteoplastics to be used must, to a great extent, be determined by experience; they should not be inserted too dry, a fairly plastic condition being the best.

The filling material should be dropped into the cavity and worked into place with as little disturbance as possible. When in place, the less the filling is manipulated the better, and it is a good practice to allow thorough hardening to take place before trimming the edges, &c.; indeed, the finishing is better accomplished at a subsequent visit. Attempts to manipulate the filling while in a semi-plastic condition tend to destroy its homogeneity and so render it less resistant to the solvent fluids in the mouth.

Humby has shown that it is possible to retard the setting of these cements by mixing them on a slab of metal with a metal spatula, the slab being made of pure copper, covered with thin layers of pure nickel. It is supposed that the setting is retarded by the absorption of the heat generated by the combination of the liquid with the powder. A large quantity of powder insufficiently mixed makes a poor filling, but it is useful for temporary work.

(*c*) *Translucent Cements.*—Translucent cements should be mixed with a bone, agate, or tantalum spatula on an agate slab. In mixing, the powder should be gradually incorporated with the fluid until a "mix" of the constituency of stiff paste is obtained. The mixing must be carried out thoroughly and no particle of powder or superfluous free acid should be allowed to remain in the "mix" when ready for insertion in the cavity.

In the preparation of the cavity, the enamel margins must be

left straight and not bevelled and the dentine must be undercut, as translucent cements do not possess adhesiveness.

The cement should be introduced into the cavity with tantalum or bone instruments. Steel instruments produce discoloration of the filling material. The cement should be gently pressed or patted into place, the instruments being coated with vaseline to prevent the adhesion of the filling. If practicable, the filling should be finished with suitable burnishers and then coated with a varnish. Where this is not possible, the filling should be trimmed with fine cuttle-fish discs coated with a plentiful supply of vaseline.

A disadvantage of some of the types of translucent cements is that they set too rapidly after insertion in consequence of the absorption of the moisture in the filling by the tooth substance. This too rapid setting may, to some extent, be overcome by mixing the cements on a thick slab of nickel covered with a layer of agate.

Translucent cements withstand the action of the mouth secretions better than osteoplastics. The tendency for cements to break away round the edges is due partly to imperfect mixing and working and partly to preparing the cavity with bevelled rather than straight edges.

(*d*) *Gutta-percha.*—To insert this material, the following plan should be adopted: The variety to be employed must be cut into small pieces and heated over a hot-water bath; if softened by being passed through a flame the gutta-percha is not evenly heated, and its properties are impaired. The cavity should be thoroughly dried, and some operators wipe it round with a solution of gutta-percha or shellac in chloroform, evaporating the chloroform with a blast of hot air before inserting the gutta-percha. By this means, the filling is made to adhere to the walls of the cavity. The heated gutta-percha is then conveyed and packed into the cavity with suitable instruments. The cavity should be somewhat over-filled, the surplus being removed with thin spatulæ heated nearly to redness. The surface should then be smoothed with a polished burnisher, or by rubbing the surface with a pledget of cotton-wool dipped in chloroform. The objection to the chloroform is that the surface is rendered more porous than when the filling is finished with a burnisher. In practice, better results are obtained by trimming the filling to a point just below the enamel margins.

(2) THE OPERATION OF EXCISION

In the operation of excision, the diseased part is cut away and the surface polished. It is applicable in very few cases, the most

suitable being the approximal surfaces of the molars and premolars when the caries is quite superficial and the surfaces are exposed.

(3) THE USE OF DRUGS

The progress of caries may be considerably retarded and sometimes arrested by the application of certain drugs, the most useful of which is nitrate of silver. Drugs can be employed with advantage for superficial caries of the cementum.

The **nitrate of silver** is applied in the form of a saturated solution, or, still better, the solid drug is rubbed over the surface. Two or three applications, at intervals of about a week, will effect a considerable hardening of the surface. The nitrate of silver precipitates the albumin in the tubules and forms an albuminate of silver which is a powerful antiseptic. The discoloration produced is an objection to its use on the anterior teeth. In cases of general softening of the cementum often seen in patients whose gums have receded, the application of nitrate of silver to the back teeth and **phosphoric acid** to the anterior teeth, with the regular use of **alcohol,** will retard and often arrest the condition. The alcohol should be used as follows:—

The teeth are dried and absolute alcohol applied to the roots either on a brush or cotton-wool, the saliva being kept away for about two minutes. The alcohol precipitates the albumin in the tubes and, in evaporating, helps to dehydrate the dentine. The application should be made at least once a day. In the extensive caries at times seen in the deciduous teeth, the application of nitrate of silver every two or three months and the regular use of the alcohol will often arrest the caries and give the patient the use of a masticating surface—a point of the greatest importance.

(4) THE OPERATION OF CROWNING

The operation of crowning may be resorted to where the destruction of the crown by caries is so extensive as to prevent the introduction of reliable fillings.

Teeth or roots which are to be crowned must be rendered quite free from periodontitis, and the root canals made absolutely aseptic. The apex of the root canal should be filled before any reaming of the canal is carried out in order to prevent injury of the periodontal membrane by foreign matter.

There are many **varieties of crowns and methods of crowning.** Broadly, they fall under two headings: (1) crowns without collars, and (2) crowns with collars. Crowns with collars are fitted with

a ring of metal which embraces the neck of the tooth to give additional stability to the crown. But the collar is liable to injure the margin of the periodontal membrane, destroy that tissue and create a stagnation area and, for this reason, collar crowns should never be used. Teeth that cannot be restored by contour amalgam fillings are not suitable for collar crowns, or indeed for any other type of crown. It is certainly possible to restore badly broken-down teeth to act as efficient masticating organs by means of collar crowns, but the gain to the masticating area is overbalanced by the injury caused to the periodontal membrane and the creation of a focus of infection which must inevitably follow. Again, if teeth are present on one or both sides of the crowns, "spaces" are sure to form which will lead to injury of the approximal teeth and hasten their loss. It is far wiser to lose the masticating area which the crown would give and keep the periodontal membrane of the approximal teeth healthy.

If it is considered necessary to crown a tooth, crowns without collars should be used in order that a "clean joint" may be obtained, the lodgment of débris prevented and the risk of injury to the periodontal membrane considerably minimized.

The manner of preparing roots for crowning depends on the class of crown. If a metal or porcelain-backed crown is to be used the labial edge of the root should be cut immediately below the free edge of the gum, the remainder of the root should be left flat and cut to leave the margin, if possible, well above the free edge of the gum. In enlarging the root canal to receive the pin of the crown, the tissue should be removed mainly from the posterior portions, as this will permit the pin to clear the tooth and so add to the strength of the crown. For porcelain crowns the surface of the root should be left flat, as a better adaptation of the crown to the root will be obtained.

In fixing crowns the root should be dried as thoroughly as possible. In crowns without collars a wafer of gutta-percha should be placed over the surface of the diaphragm, the crown forced well home, then removed and all excess gutta-percha cut off. The crown should then be fixed in the root with an oxy-phosphate cement.

(5) THE OPERATION OF EXTRACTION

In all cases of caries where one of the above methods cannot be employed the tooth should be removed. For the methods of extracting teeth, see chapter XXVII.

CHAPTER XIV

Destruction of Teeth from Causes other than Caries: Abrasion. Attrition

In caries of the teeth, the tooth substance is gradually destroyed by the action of acids and micro-organisms. Progressive destruction of the tooth substance may, however, be caused by other agencies and of these the most important is abrasion.

(A) ABRASION

The term **abrasion** is used to denote the destruction of the tooth substance by friction with a foreign body, such as a denture, pipe, tooth-brush or tooth-powders. The action of a clasp on a denture produces a shallow depression, the surface of which usually presents an eburnated appearance. Friction on the tooth from the use of a clay pipe results in a destruction of the occlusal portion of a tooth or teeth, a curve-shaped notch being formed.

The commonest cause of abrasion is the tooth-brush when used in combination with abrasive tooth-powders. With the gradual recession of the gum, the neck of the tooth becomes exposed and the tooth-brush, if used transversely, will tend to produce V-shaped cavities in the dentine. The cavities are mostly found upon the maxillary canines and the mandibular canines and first premolars—the teeth which form the prominent parts of the curves of the arch. At times abrasion is more marked upon the left than the right side, and this is no doubt due to the fact that a right-handed person would apply more force in brushing the teeth on the left side.

Occasionally the destruction of the enamel surface may be caused by the use of the tooth-brush and give rise to the condition usually known as "erosion." In this type of abrasion the appearances of the teeth vary. The labial surfaces of the anterior teeth may be affected, in which case the condition may be limited to one tooth or may involve several. The earliest indication is a slight depression which gradually deepens and extends towards the incisive margin. Gradually a cup-shaped depression is formed, which is deepest towards the cervical margin and becomes shallower as the

incisive edge is reached. Fig. 556 is an example of an advanced case. Sometimes the teeth look as if they had been pared down with a knife in a direction sloping from the labial to the lingual

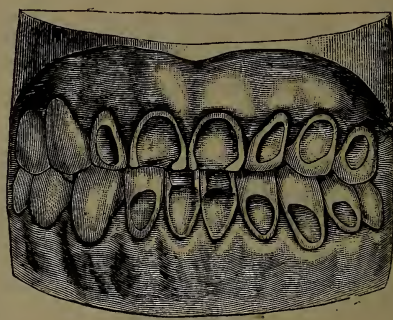

Fig. 556.[1]

surfaces and, when the mouth is closed, a considerable interval is left between the maxillary and mandibular teeth (fig. 557). To the naked eye, the teeth attacked appear hard and polished, with,

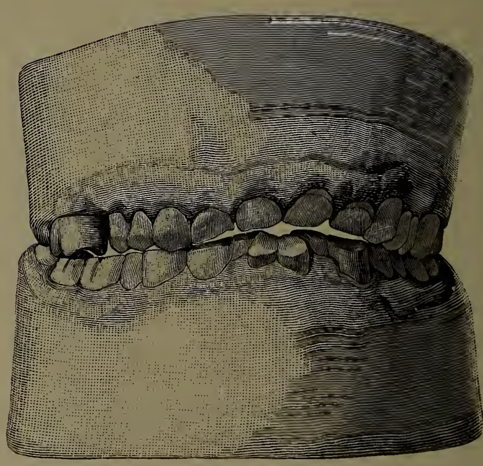

Fig. 557.

occasionally, a darkish film on the surface The dentine exposed is hypersensitive.

Sections of the dentine simply show the fibrils or tubes ending abruptly as if cut with some sharp instrument. The tooth sub-

[1] From "The American System of Dental Surgery."

stance adjacent to the eroded surface cannot be stained, and this point is worthy of attention.

Changes in the Pulp.—In teeth showing abrasion, formative activity occurs in the pulp, which results in the formation of adventitious dentine at the pulp end of the affected dentinal fibrils. If the process is rapid, the dentine may be destroyed more quickly than the protective dentine is formed, in which case the pulp becomes exposed and a septic inflammation occurs.

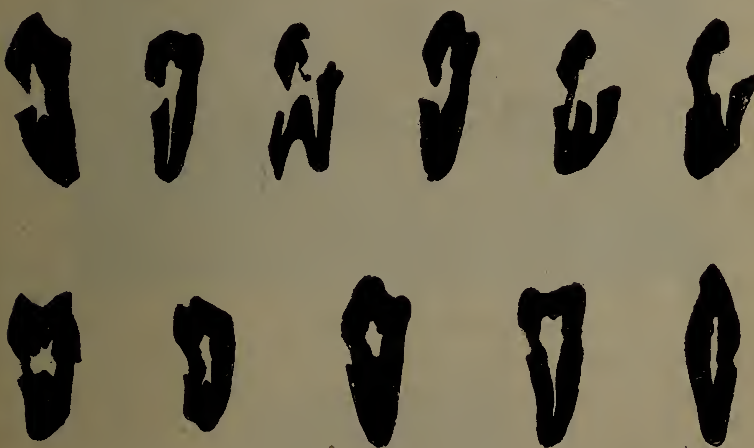

FIG. 558[1] (Miller).

Experimental Investigation.—For many years the cause of the curious destruction of the tooth tissue termed "erosion" was obscure. Various theories were advanced, but it has now been demonstrated by clinical observations and experimental evidence that "erosion" is to be attributed to the abrasive action of gritty tooth-powders. The earliest investigations were made by Berdmore, who was the Court Dentist to George III, and he refers to his experiments in the following words:—

"I fastened in a vice a sound and well-enamelled human tooth, placing the convex side uppermost. I then took a brush, wetted and charged with a certain tooth-powder, which I had bought for the purpose, and in less than an hour, by rubbing quickly with this brush and powder, I wore away entirely the enamel of the part which was exposed to their action.

[1] From *Dental Cosmos.*

"The like experiment I repeated with all the different tooth-powders which are sold in this town, and found the same effects varied only a little in time, according to the coarseness or fineness of the powder, and the different hardness of the enamel.

"Now it is well known that a number of people brush their teeth with powders of this kind two or three times a week; and if we allow that the brush and powder generally act on the front teeth briskly for one-fourth of a minute each time, in the space of a month they act three minutes, or in two years seventy-two minutes; that is to say, in the space of two years the teeth have undergone a great deal more brushing than was found sufficient to destroy the finest and best enamel.

"Hence, those that brush with powders only once a week do not destroy the enamel in less than five or six years, and those who use powders but rarely can never be brought to believe that their teeth are injured by them, because the destruction creeps on too slowly to be observed."

This work of Berdmore seems to have been forgotten. Miller more than a century afterwards published a series of articles[1] in which he conclusively showed that "erosion" so-called was due to the abrasive action of the tooth-brush and tooth-powder.

If a tooth is subjected experimentally to the action of the tooth-brush and powder, defects can be produced, the loss of tissue depending largely on the character of the powder used.

In order to make a satisfactory experiment with tooth-brush and powder the tooth to be experimented upon should be fixed in plaster of Paris, with gutta-percha on either side to represent the approximal teeth and prevent the brush from acting too much on the sides of the tooth.

Fig. 558, from Miller, shows the effects produced by different tooth-powders applied with a brush for two hours. Fig. 559 shows the result of brushing for eighteen hours with a form of tooth-paste which is very commonly used. The amount of friction applied to this tooth roughly corresponded to brushing for ten seconds daily for eighteen years. The tooth tissues and the gold filling in the first premolar are worn away equally.

An interesting experiment, undertaken by Miller, consisted in arranging a bar of wood opposite the cutting edges of the mandibular front teeth at a distance of from 2 mm. to 3 mm., and brushing for eighteen hours with an English tooth-paste. The

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[1] The student is advised to read Dr. Miller's articles on this subject in the *Dental Cosmos*, January, February, March, 1907.

result is shown in fig. 560. Not only have grooves been cut near the necks of the teeth, but considerable loss of tissue has taken place at the cutting edges. This experiment approximately simulates the action of those who bring the teeth almost edge to edge when

FIG. 559 [1] (Miller).

FIG. 560 [1] (Miller).

brushing them, with the result that the bristles of the brush work freely along the cutting edges of the teeth and produce abrasion. The condition shown in fig. 557 is brought about in this way.

In several of the theories advanced to account for this curious abrasion of the teeth the causative action has been attributed to an

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[1] From *Dental Cosmos*.

acid. The action of acids varies on the different tooth tissues. "Some acids form soluble and others insoluble compounds which may be precipitated upon the surface of the tooth or in its superficial layers." Certain acids, e.g., hydrochloric, nitric, lactic, &c., decalcify dentine more rapidly than enamel; other acids, such as oxalic, tartaric, or mucic, act with equal intensity on both enamel and dentine. The surface left by acid action is rough and there is therefore no difficulty in distinguishing between the effect of acid action and abrasion, as the latter leaves a polished surface.

Workers in dynamite manufactories often suffer from a disease which causes the loss of the crowns of the lower incisors and the cutting edges of the upper incisors, the defective portions of the teeth presenting a smooth polished surface. Miller found that a similar condition could be produced by exposing teeth to the vapour of sulphuric and nitric acids (the acids used in the manufacture of dynamite), and then slightly brushing the affected surface. The eroding body is nitrogen peroxide.

Water charged with carbonic acid has a marked decalcifying effect on dentine and enamel and it is conceivable that, when carbonic acid is present in the saliva in excess, it might have a deleterious effect on the teeth.

If teeth be acted upon by a constant stream of dilute acid solution, destruction of the tooth substance will ensue, but the surface will be rough, showing acid action, and not smooth as in cases of abrasion.

In one experiment undertaken by G. V. Black[1] two fresh healthy premolars were placed with their approximal surfaces together, the roots being enveloped with gutta-percha so that only the crowns were exposed; these were placed in a jar containing dilute hydrochloric acid (1 in 400), and, by means of an ingenious apparatus, a current was obtained, the teeth being arranged in such a way that the current, in impinging upon their outer surfaces, struck one surface with greater force than the other, the result being the disappearance of the cusps and the formation of a groove between the teeth; this groove was more marked upon the surface which received the greater force of the current. Many other experiments were made, and it was found that strong solutions produced general softening, while a solution of 1 of acid in 5,000 of water had no appreciable effect after three months' trial.

Head[2] has investigated the action of acids on enamel, and he

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[1] "American System of Dental Surgery," vol. i, p. 1004.

[2] *Dental Cosmos*, vol. xlix, p. 801.

has shown that the structure resists the decalcification of acids and acid salts most unevenly and erratically. In experiments with 1 : 20, 1 : 2,000, and 1 : 20,000 solution of acid sodium phosphate, he found that while with 1 : 20,000 (solution) decalcification of the enamel did not start so quickly as with 1 : 20, the action of the 1 : 20,000 was more uniformly progressive and ended by cutting the enamel much more deeply than the 1 : 20 solution. Head has also shown that the saliva considerably inhibits the action of carbonic acid and many other acids, such as lactic, citric, &c.

The Action of Acid in Combination with Mechanical Action.— For these experiments, the teeth were subjected to the action of the acid by means of a thin layer of cotton-wool placed on the surfaces of the teeth and friction with a tooth-brush was then applied. Every precaution was taken to simulate the condition met with in the mouth, and various acids were tried. In one of Miller's experiments, " six teeth, central, lateral, canine, premolar, first and second molars, were placed in a curve to reproduce the natural arch, and were bathed with 5 per cent. solution of phosphoric acid for thirteen hours, brushed hourly for two minutes with 50 per cent. pumice, and then for eleven hours brushed hourly for three minutes, and for seventy-three hours four minutes hourly." The result of this experiment is seen in fig. 561. The canine and premolar were

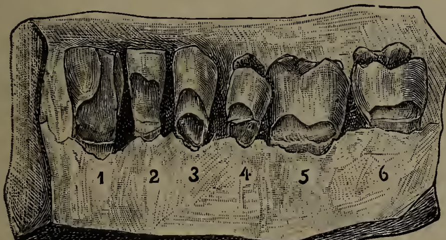

FIG. 561[1] (Miller).

filled with gold and gutta-percha, respectively, and these fillings project above the surrounding dentine.

A point clearly demonstrated by Miller's experiments is that acid action does not by itself produce wasting of the enamel to the extent seen in abrasion, but, in conjunction with mechanical agencies, considerably accelerates the abrading process. With dentine, the action of the acid is to convert the tissue into a soft but tough material which naturally resists friction more than the

[1] From *Dental Cosmos.*

hard and brittle uncalcified tissue. The action of the acid on the dentine, however, varies. Acids which rapidly decalcify the dentine, such as hydrochloric and lactic, exert most influence in retarding the effects of friction; while those which act slowly on the dentine (oxalic, tartaric, &c.), as well as those which have a macerating effect on decalcified dentine, exert but little influence.

The result of an experiment undertaken to show the difference between mechanical friction alone and mechanical friction plus acid action is shown in figs. 562 and 563. The teeth in the left half

FIG. 562 [1] (Miller).

FIG. 563 [1] (Miller).

of the mandible were treated with a ½ per cent. to 1 per cent. solution of acid calcium phosphate applied on cotton-wool[2] and the right half with water, also applied on cotton-wool. Both sides were brushed twice a day with different powders for two and one-third years. The destruction is much more marked on the left side which was treated with acid calcium phosphate.

(3) Etiology.—Experimental evidence suggests that so-called "erosion" is really a type of abrasion and is due to the mechanical action of the tooth-brush and gritty powder. The question arises: Is it possible that acid agents may be present in the mouth in certain pathological conditions and so aid the abrading process? Many authors maintain that "erosion"[3] is intimately associated with "gout," and that in gouty subjects acids capable of affecting the tooth tissues are produced in the mouth. Clinical observations

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[1] From *Dental Cosmos*.

[2] Miller in this experiment does not say how long the acid calcium phosphate was allowed to remain in contact with the tooth.

[3] The term "erosion" has been allowed to remain in the text in several places as it is difficult, and perhaps inexpedient, to do away altogether with a term which has been so universally used for many years.

on patients in private practice certainly tend to show that tooth wasting is more marked in those of gouty diathesis than in others. On the other hand, Miller and S. P. Mummery examined patients in the hospitals of London and Berlin and found no case of erosion in twenty-four cases of gout and ninety-nine of rheumatism (eighty-nine chronic and ten acute). Caries at the necks of the teeth was found in many of the patients, but no disintegration of the enamel. Riegner, of Breslau, also examined amongst hospital patients two cases of gout and 115 cases of articular rheumatism and found no wasting of the teeth. These data are interesting when considered in connection with the fact that hospital patients rarely use a tooth-brush.

Brubaker[1] considers that the source of the acid which affects the teeth is to be found in an abnormal secretion of the mucous glands of the cheeks and lips. These glands are muciparous, and their secretion is composed of water, mucin and inorganic salts, the chief of which, sodium phosphate, imparts to the fluid its alkalinity. In certain conditions, such as "gout," the secretion increases in quantity and is acid in reaction, the acid sodium phosphate which is formed acting as the decalcifying agent.

Kirk,[2] who has carefully studied the question of the connection between the saliva and erosion, is of opinion that "erosion" is intimately connected with the gouty and rheumatic diatheses.

He considers that when the erosion is "general," that is when it attacks the teeth generally, lactic acid is the solvent, but that, when the condition is localized, the agent is acid sodium phosphate or acid calcium phosphate derived from abnormal secretion of the mucous glands.

Cook[3] contends that mucic acid is an important acid agent in the production of "erosion," and thinks that it is produced by a series of changes from lactose. It is, however, an open question whether mucic acid is ever present in the mouth.

Michaels[4] states that, where "erosion" is found, the saliva of the patients contains an increased amount of sulphocyanide in the form of the ammonium and potassium salts and that by submitting the tooth to a slow drip of a solution of sulphocyanide of

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1 *Internat. Dent. Journ.*, p. 742, 1894.

2 *Items of Interest*, July, 1902, and *Dental Review*, May, 1903.

3 *Dental Review*, May, 1906, p. 461.

4 "On the Rôle of Systemic Hyperacidity and of Sulphocyanides in the Saliva in Chemical Abrasion of the Teeth," *Internat. Dent. Journ.*, vol. xxi, p. 248.

potassium for a few days he was able to produce conditions similar to erosion.

A marked destruction of tooth tissue is occasionally seen in patients who consume a large amount of fruit in the form of oranges, grapes and lemons, but in these cases the effect produced on the teeth is not the same as in cases of "erosion." In the case of a patient who was frequently sucking lemons and had acquired the habit of sweeping the tongue over the labial and then over the palatal aspects of the maxillary teeth it was found that the enamel had almost disappeared.

During recent years the number of patients showing "erosion" of the teeth has progressively diminished and the condition is now seldom seen. Concurrently, the materials used for cleaning the teeth have undergone a change, tooth-pastes having largely superseded tooth-powders. The friction agent has therefore been disappearing from the dental toilet, but conditions likely to give rise to abnormal secretion of the salivary glands have still been present.

From the foregoing statements it will be seen that varying opinions as to the cause of "erosion" are held by those who have investigated the subject. The facts elicited from a general review of all the information at present at our disposal would seem to show conclusively that **the condition is due to the abrasive action of the tooth-brush and tooth-powders.**

(4) Treatment.—In the first place, tooth-powders should be avoided and a soap with a soft brush used for cleansing purposes. The teeth must on no account be brushed "crosswise." If the abraded areas are painful, they may be touched with phosphoric acid, chloride of zinc, or, if in a place which does not show, nitrate of silver may be used, or a paint may be prescribed, the patient being instructed to dry the tooth and paint it with the solution, keeping the tooth dry to allow the material to harden. The following will be found useful:—

℞	Gum-mastic (powder)	ʒi
	Zinc chloride	gr. v
	Chloroform	℥ss

Mix. To be used as a paint.

If the cavities are deep and are likely to harbour food débris, they should be filled.

(B) ATTRITION

Attrition is a wearing away of the tooth substance, caused by the grinding of one tooth surface over another. It is seen more frequently in the teeth of the aged and in the deciduous teeth. The

amount of attrition depends to a great extent upon the character of the food, the density of the tooth substance, and the power of mastication. The surfaces of all the teeth may be affected, or only one or two teeth may be attacked. When confined to one or two teeth, the attrition is generally due to some irregularity of the bite. Fig. 564 shows a good example of attrition due to an irregularity of the bite—the mesial angles of the maxillary central incisors impinge upon the mandibular central incisors.

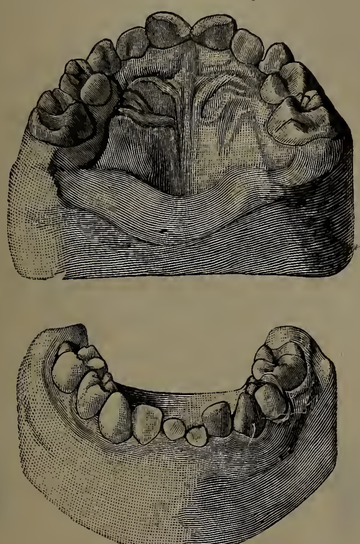

Fig. 564.

Broca has suggested the recognition of **four degrees of wear**:—

In the **first**, the enamel alone is worn without any obliteration of the cusps; in the **second**, the tubercles of the crown have disappeared, and the dentine is exposed; in the **third**, the height of the tooth is still further reduced; in the **fourth** the wear has extended to the neck, the crown having entirely disappeared, and either the pulp cavities are invaded, or barriers of adventitious dentine have formed.

Involuntary grinding of the teeth, leading to undue attrition, is not uncommon in children and is sometimes met with in adults, more especially those with gouty or rheumatic tendencies. Marie and Pietkiewicz[1] state that the habit of grinding the teeth

[1] *Revue de Stomatologie,* March, 1907.

frequently develops in the course of disorders of the central nervous system.

Examined microscopically, the dentinal tubes in cases of attrition will be seen to end abruptly upon the worn surface, while the pulp chamber will show the formation of adventitious dentine, though the adventitious dentine will not always be found to have kept pace with the destructive process.

Treatment.—In most cases, treatment is unnecessary. If the posterior teeth have been lost, and the anterior teeth are being worn away through bearing the brunt of mastication, the bite should be taken off the anterior teeth by means of dentures. If the patient refuses to submit to dentures, the progress of the destruction can be arrested by filling the cavities with metal and bringing the filling over the edges of the enamel in such a way that, in occlusion, the fillings come in contact and so arrest the progress of tooth destruction. The latter treatment is effectual, but the appearance produced is somewhat unsightly.

The hypersensitiveness of dentine, which at times accompanies rapid attrition, should be treated as indicated on p. 426.

Fig. 565.—Mandibular first molar, showing attrition.

Fig. 566.—Mandibular first molar, showing attrition which is more marked on the posterior than on the anterior aspect.

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CHAPTER XV

Diseases of the Pulp

Acute Pulpitis—Chronic Pulpitis—Adventitious Dentine—Regressive Changes—Exceptional Pathological Conditions

(A) LOCAL REACTION TO INJURY—INFLAMMATION—PULPITIS

The local adaptive changes which result from injury to the pulp are generally known as "pulpitis." Two grades of inflammation are recognized, namely, the acute and the chronic; in the former, the development of the inflammatory process is rapid and is accompanied by marked clinical symptoms, while, in the latter, the reaction is slow in development and is accompanied by feebly marked clinical signs, indeed, in some instances, no clinical signs are apparent.

(1) Acute Pulpitis

Causes.—Acute inflammatory reaction in the pulp may arise from *traumatism*, such as the rupture of the apical vessels from dislocation of the tooth, fracture of the tooth involving the pulp, and laceration of the pulp tissue in the preparation of the tooth for filling. Another group of causes is the injudicious use of *physical and chemical agents*, for example, the freezing of teeth with ethyl chloride, or the use of a drug like arsenic for the treatment of sensitive dentine. The commonest cause of acute pulpitis is injury from *bacterial toxins* which reach the pulp tissue either through a carious cavity, or, more rarely, via the periodontal membrane, the latter being seen in advanced cases of periodontal disease.

Morbid Anatomy and Pathology.—The changes in the pulp tissue resulting from injury are similar to those which occur in other vascular structures. The process may terminate in *resolution* when the injury has taken the form of a concussion or slight dislocation of the tooth. Resolution may follow after injury of the apical vessels, but this is rare, and in this connection the following case recorded by A. S. Underwood[1] is interesting. Whilst performing

[1] *Trans. Odonto. Soc.*, vol. xviii, p. 98.

immediate torsion on a superior lateral incisor, the tooth was completely dislocated and fell on the floor. It was sterilized and replaced. Two years afterwards the tooth responded to thermal changes and showed no degenerative changes.

In other cases the reaction in the tissues may be so intense in character as to lead to *gangrene* of the pulp. Injury to the pulp is frequently followed by gangrene, the reason being that this delicate tissue is enclosed by unyielding walls and that the increased pressure in the cavity leads to vascular obstruction.

When the injury is due to bacterial toxins, *suppuration* usually follows, and, in cases where the infection is intense, "gangrene" may occur. When suppuration is once established in a part of the pulp, the remainder rapidly becomes involved and the whole of the tissue is destroyed.

The early stages of suppuration of the pulp are shown in fig. 567. In the zone bordering on the abscess (*f*), the cells show a tendency to the formation of fibroblasts, which would seem to indicate protective action on the part of the pulp to cut off the pus from the remainder of the tissue. In the tusks of elephants examples of the encapsulation of pus are often met with, and in man it would seem to occur occasionally. Gysi[1] records a case where an abscess in the cornua of a maxillary first molar had been isolated from the rest of the pulp by a wall of secondary dentine, and Miller[2] figures a tooth in which the appearances suggest that an abscess cavity had been bridged over and separated from the main pulp cavity.

Occasionally the pulp shows a wonderful power of recovery from injury, as shown in cases where an unsuccessful attempt has been made to remove a tooth and a portion of the root containing a living pulp has been left behind, the superficial portion of the pulp in time being replaced by secondary dentine. A detailed account of a case of this type is given by C. S. Tomes.[3] Sections of this tooth showed that the widely exposed pulp had been covered in by a layer of secondary dentine, and that, in places, fragments of the original dentine had become embedded in the new tissue (see figs. 568 to 570).

Bacteriology.—The bacteriology of the pulp has been investigated by K. Goadby and J. Barrett.[4] They found that in cases where a

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1 *Schweizerische Vierteljahrsschrift für Zahnheilkunde,* 1900, p. 254.

2 *Dental Cosmos,* vol. xliii, p. 850.

3 *Trans. Odonto. Soc.,* vol. xxviii, p. 183.

4 *Seventeenth Inter. Congress of Medicine,* Section of Stomatology, Part II, p. 31.

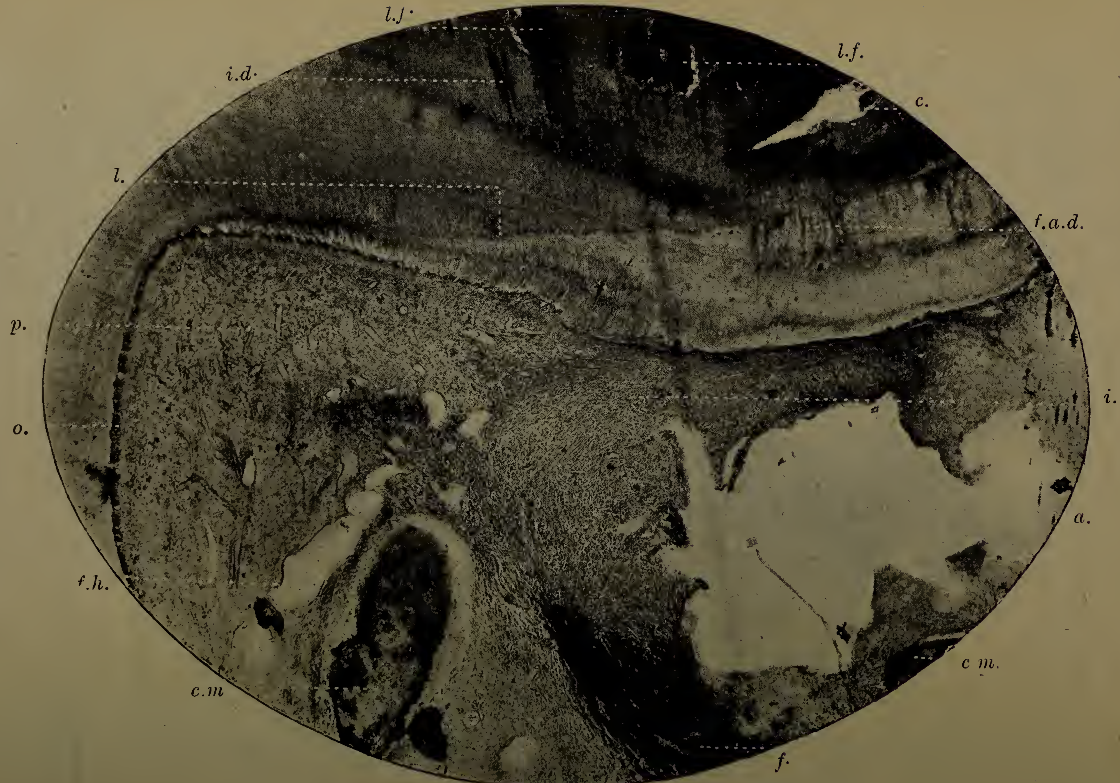

FIG. 567.—Vertical section of human molar tooth affected with caries and inflammation of the pulp. (*c.*) carious cavity; (*i.d.*) dentinal tubes infected with micro-organisms; (*l.f.*) liquefaction foci; (*l.*) original limit of the pulp cavity; (*f.a.d.*) fibrillar adventitious dentine; (*p.*) pulp tissue apparently but slightly affected by the inflammatory process; (*o.*) original odontoblasts; (*i.t.*) acute inflammation of the pulp tissue; (*a.*) abscess cavity; (*f.h.*) hyperæmic blood-vessel; (*c.m.*) deposit of calcoglobulin; (*f.*) fibroblasts.

From "The Histology and Patho-histology of the Teeth," by A. Hopewell-Smith.

Fig. 568.[1]—General view of the secondary (adventitious) dentine, showing the pulp cavity beneath it and the dentine of the original tooth, which appears very dark. A thin strip broken off the old dentine is embedded in the secondary dentine.

Fig. 569.[1]—Another view of the secondary (adventitious) dentine.

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[1] From *Trans. Odonto. Soc.*

layer of hard dentine existed between the carious cavity and the pulp chamber, micro-organisms were absent in the pulp tissue.

In ten cases examined in which the carious cavity communicated with the pulp they were able to demonstrate bacterial infection in seven cases:—

Streptococcus brevis	7	cases
Micrococcus salivarius (*M. catarrhalis*) ...	7	,,
Strepto bacillus	3	,,
Bacillus necrodentalis	1	case
Streptococci other than *S. brevis* ...	2	cases

Fig. 570.[1]—A portion of the displaced original dentine embedded in the secondary (adventitious) dentine.

Symptoms.—The symptoms of acute pulpitis are pathognomonic—sharp shooting pain, often of a throbbing character, which is generally more severe at night when the patient assumes the horizontal position. Thermal changes also lead to severe paroxysms of pain, although in the early stages of acute inflammation cold produces relief by constricting the blood-vessels. Acute pulpitis must be distinguished from acute periodontitis, and the main points of difference are briefly as follows:—

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[1] From *Trans. Odonto. Soc.*

Acute Pulpitis.	Acute Periodontitis.
Pain sharp, throbbing, or lancinating — intermittent and reflected.	Pain dull, heavy, and constant.
Thermal changes to the teeth cause pain.	Thermal changes do not cause pain.
Pressure or tapping on the tooth causes no pain.	Pressure or tapping on the tooth causes pain.
Slight pressure on a piece of cotton-wool inserted in the cavity generally causes acute pain.	Slight pressure on a piece of cotton-wool inserted in the cavity does not cause pain, except through pressure transmitted to the periosteum.

Attention to these points will assist in diagnosis, but it must not be forgotten that with acute inflammation of the pulp there is at times a slight inflammation of the periosteum through continuity of the tissues.

Treatment.—When the inflammation is due to trauma or to the action of physical and chemical agents, there is reasonable probability that resolution will occur. Therapeutic measures must be directed towards the avoidance of fresh injury to the tooth, and counter-irritation should be applied to the gum covering the root, in the form of a drug, e.g., strong tincture of iodine. If the dentine has been exposed by the trauma, the exposed surface should be treated with a strong solution of nitrate of silver. Should the pulpitis be the result of drugs used for treating sensitive dentine, the use of the drugs must be discontinued and the cavity syringed and filled with a non-conducting and non-irritant filling, such as oxysulphate of zinc. If, however, the clinical features suggest that resolution is not likely to occur, the pulp must be immediately removed. With pulps injured by laceration during cavity-preparation or by bacterial toxins, experience teaches that extirpation is the best treatment.

(2) Chronic Pulpitis

Chronic pulpitis follows on injuries similar to those leading to acute pulpitis. The reaction of the tissues in chronic pulpitis is different from that seen in the acute form, and this is due to the fact that in chronic pulpitis the injury is constant, though of lesser intensity.

Morbid Anatomy and Pathology.—The character of the reaction of the pulp tissue, when the injury is of long duration, varies considerably. In the first place we will deal with the condition where

the pulp cavity is exposed and the pulp tissue injured by constant doses of bacterial toxins. In such cases suppuration may occur and the pulp tissue is destroyed by a progressive ulceration, or there may be an overgrowth of the pulp tissue (hyperplasia) giving rise to a flesh-like mass in the carious cavity. A section through the growth will show that it is mainly composed of granulation tissue which has a tendency to develop into fibrous tissue (fig. 572). The surface is often covered with a layer or several layers, of squamous epithelium (fig. 571). The presence of the epithelium has been

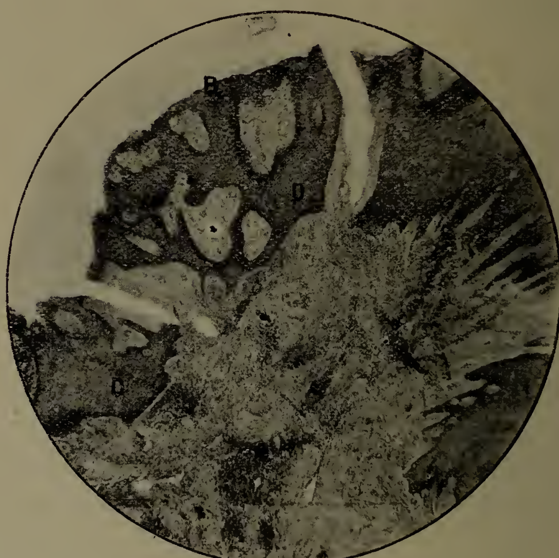

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Fig. 571.—Hyperplasia of the pulp—productive pulpitis. Longitudinal section. (A) granulation tissue; (B) epithelial surface; (D) columns of epithelial cells extending deeply into the growth.

attributed to "skin-grafting," but an explanation which seems more likely to be correct is that given by Hopewell-Smith[1]—namely, that where the epithelial cells of the gum in the neighbourhood of an approximal carious cavity are irritated by a sharp edge of dentine, they proliferate and extend by direct continuous growth on to the surface of the exposed pulp.

Where from any reason such as caries, abrasion, &c., the dentine is exposed and the dentinal fibrils are injured, a definite reaction

[1] *Brit. Dent. Journ.*, September, 1909.

takes place in the pulp in the neighbourhood of the pulp end of the dentinal fibrils which have been injured (fig. 573).

It is interesting to note that the fibrils affected appear to be more calcified than in other portions of the tooth substances, pointing to the probability that a definite reaction to the injury takes place in the fibrils. The extra calcification is shown by the greater difficulty in staining the fibrils.

FIG. 572.—Hyperplasia of the pulp—productive pulpitis. Longitudinal section, highly magnified. (A) fibrous stroma; (B) large granular cells (no capillaries visible).

FIG. 573.

The new tissue formed has been termed by Hopewell-Smith "*adventitious dentine*" (secondary dentine).

The structure of adventitious dentine varies considerably in different circumstances, and the variation is probably dependent to a great extent upon the nature of the irritant, this, in its turn, affecting the rapidity of formation. Thus, *five varieties* have been observed and described.[1] These are known as *areolar*, *cellular*, *fibrillar*, *hyaline*, *and laminar* adventitious dentines. The first named is the commonest variety, and the least frequently found is the hyaline.

The *areolar* variety (fig. 574), which in its general characteristics

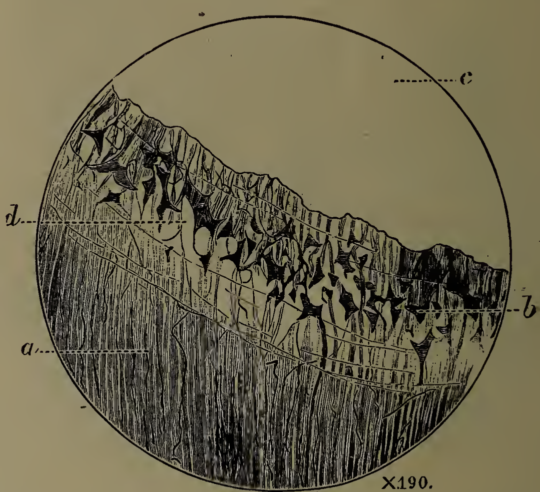

Fig. 574.—Areolar adventitious dentine. (*a*) carious dentine; (*b*) interglobular spaces; (*c*) pulp cavity; (*d*) newly formed and irregular tubed dentine.

resembles a dentine filled with interglobular spaces, would seem to occur when the new tissue has been formed quickly as the result of rapid caries. Such newly formed tissue possesses but little resistance to the carious process and becomes quickly infected (figs. 575 and 576).

The *cellular* type differs from the areolar variety in containing, in the matrix, cells which may be fusiform or round (fig. 577).

The *hyaline* variety is a clear, homogeneous, structureless deposit of dentine (fig. 578); and the *laminar*, as the name suggests, is tissue with a laminated form (fig. 579).

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[1] See *Trans. Third International Dental Congress,* Paris, 1900.

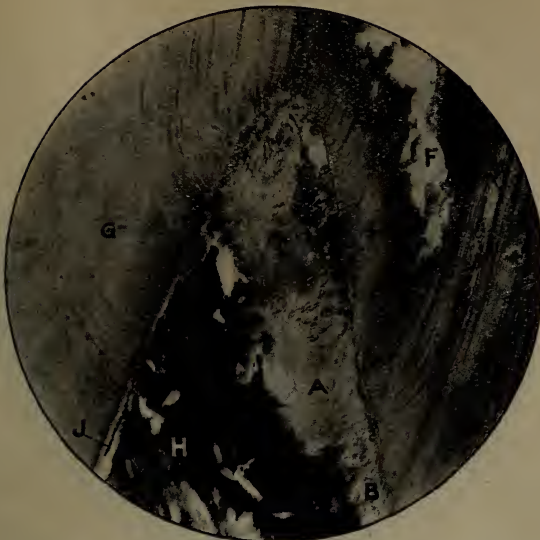

FIG. 575.—Photomicrograph by Hopewell-Smith. Areolar and fibrillar adventitious dentine. (A) adventitious dentine with fibrillar structure at B, and areola at C, which at D is infected with micro-organisms from caries at E; (F) carious cavity; (G) primary dentine; (H) pulp tissue showing signs of reaction; (I) junction of primary and adventitious dentine; (J) layer of odontoblasts.

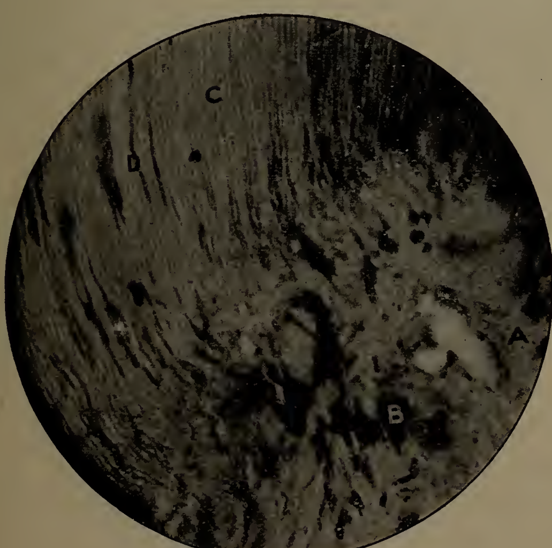

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FIG. 576.—Photomicrograph by Hopewell-Smith. Adventitious dentine infected by micro-organisms from the primary dentine. (A) adventitious dentine; (B) masses of micro-organisms; (C) primary dentine; (D) carious dentine.

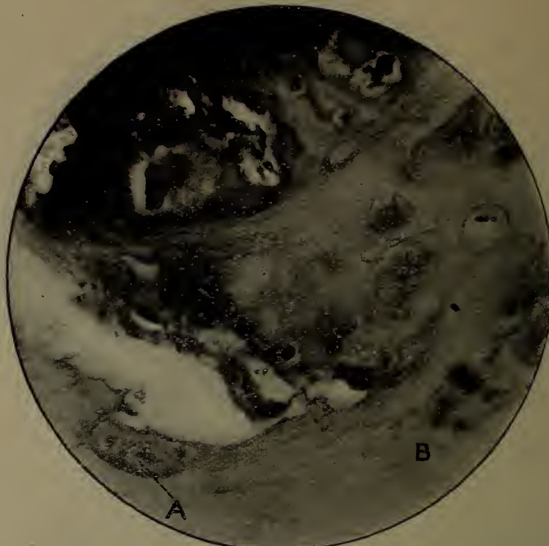

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Fig. 577.—Photomicrograph by Hopewell-Smith. Cellular adventitious dentine. (A) encapsuled cells with nuclei; (B) structureless matrix.

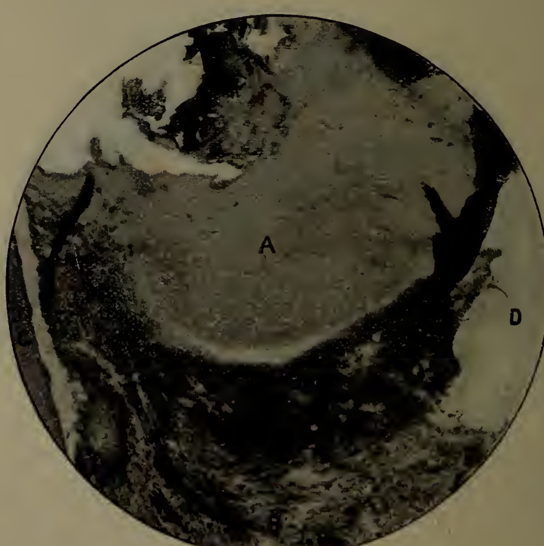

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Fig. 578.—Photomicrograph by Hopewell-Smith. Hyaline adventitious dentine. (A) ground-glass-like dentine; (B) pulp tissue showing reaction; (C) primary dentine; (D) abscess cavity.

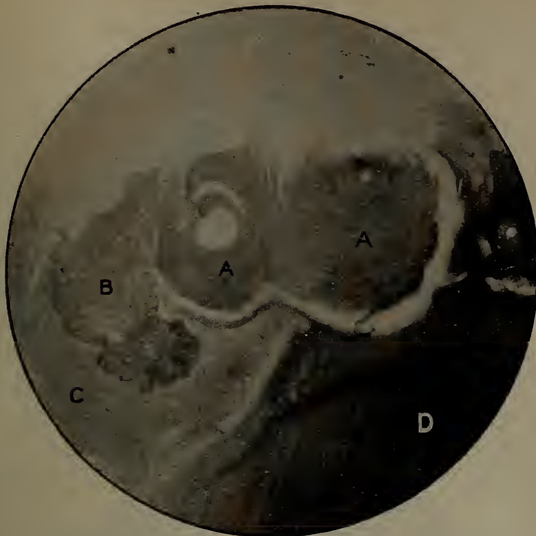

FIG. 579.—Photomicrograph by Hopewell-Smith. Laminar adventitious dentine. (A) laminar dentine; (B) cellular dentine; (C) pulp tissue showing signs of reaction; (D) primary dentine.

In the *fibrillar* form the tissue may approximate to normal fine-tubed dentine, a slight abrupt bend of the tubes being all that there is to mark the junction of the two tissues. (See fig. 580.) In many specimens, however, the tubes are not quite so regular and plentiful

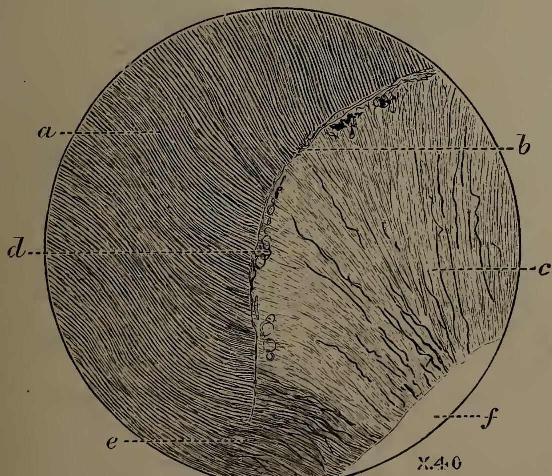

FIG. 580.—(Longitudinal section.) (*a*) normal dentine; (*b*) limit of original pulp chamber and line of demarcation; (*c*) adventitious dentine; (*d*) group of interglobular spaces; (*e*) tubules intermingling freely; (*f*) pulp chamber.

as in normal dentine, but the boundary line between the normal and the new dentine is generally well marked. A few fibres are generally seen continued from the ordinary dentine, and these, instead of traversing through the whole thickness of the new deposit, end in fine-pointed extremities (fig. 581). The fibrillar variety of adventitious dentine follows prolonged injury of a low intensity.

Symptoms.—The symptoms arising in connection with chronic pulpitis vary according to the type of injury and the susceptibility of the patient to pain. Some individuals whose mouths contain several teeth with chronically inflamed pulps experience no objective symptoms, while others suffer severe pain, both local and referred,

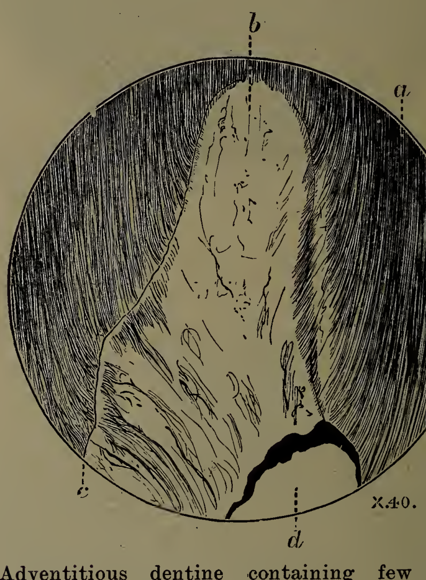

Fig. 581.—Adventitious dentine containing few tubes. (*a*) normal dentine; (*b*) adventitious dentine tubes are few and very fine; (*c*) line of demarcation; (*d*) pulp chamber.

with the slightest injury to pulp tissue. Suppurative pulpitis in the early stages is generally accompanied by pain to thermal changes. In the later stages, however, cold gives a certain amount of relief, while heat causes intense paroxysms of pain. This symptom of *increased pain to heat is almost diagnostic of a suppurating pulp*. As the suppuration approaches the apex the inflammation spreads to the periodontal membrane and symptoms of inflammation of that tissue appear. Pain is more marked during the night than during the day, and is very likely to become wandering in character. It may be referred to another tooth, or to other

parts of the head (see chapter XXIV). In the case of exposed cavities the act of mastication will usually cause pain. When the pus is confined, for instance in suppurative pulpitis under a filling, the pain may be intense. It is usually constant in character, with acute exacerbation on the application of heat to the tooth. Opening the pulp chamber in these cases gives almost instant relief.

Where there is overgrowth of the pulp, symptoms may be altogether absent, the surface of the pulp being insensitive to touch. When the overgrowth of the pulp has encroached on the carious cavity and is fibrous in character, it must be diagnosed from localized hypertrophies of the muco-periosteum.

The points of difference are: In the former, absence of pain to pressure, and no great liability to hæmorrhage; in the latter, extreme sensitiveness to pressure and liability to hæmorrhage on slight injury. A careful examination will show that the growth in the one springs from the pulp chamber, and in the other from the gum around the neck of the tooth.

When the inflammatory process follows an injury other than bacterial toxins, the only symptom may be slight discomfort to thermal changes, and even this symptom may be absent.

Treatment.—When the chronic pulpitis arises from infection via the tooth cavity or periodontal membrane, the pulp must be removed. Where suppuration is present, the surface of the pulp should be rendered as aseptic as possible before removal is attempted.

(B) REGRESSIVE CHANGES

(1) Senile Atrophy.—In senile atrophy there is a tendency to fibrotic changes throughout the body, and a similar process occurs in the tooth pulp. These changes have been ably described by Wedl[1] and Hopewell-Smith.[2]

The latter has shown that complete fibrosis of the pulp—in which all the elemental tissue has degenerated or been changed, the cells, the vessels, the nerve fibres, &c.—may occur in teeth of the deciduous series.[3] To the naked eye the pulps appear flattened and shrivelled and are often brittle in consistency. The colour is grey-yellow or reddish-brown according to whether it contains a smaller or larger amount of necrotic blood.

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[1] "The Pathology of the Teeth," p. 237.

[2] *Journn. Brit. Dent. Assoc.*, March, 1892.

[3] *Dental Cosmos*, December, 1909.

Microscopical Appearances.—*Under low magnifying powers* a superficial reticular network is seen, at the edges of which the odontoblasts appear shrunken, while, if the atrophy is far advanced, they will have disappeared. The blood-vessels appear larger than usual and have thin walls, so that it is impossible to distinguish between arteries and veins. The nuclei in the sheath have also disappeared. The vessels are seen to take an irregular course and

FIG. 582 (Wedl).

FIG. 583 (Wedl).

to intertwine freely, marked constrictions due to the contraction of the connective tissue trabeculæ being present in places. *Under higher powers* (300 diameters) the network becomes more plainly visible, the bundles of tissue interlacing and forming alveolar-like spaces, the central ones corresponding to the shrunken blood-vessels. The nerve sheaths are fatty, granular, and, in places, covered with

small concretions of lime. In various places staining is seen. The staining arises from the colouring matter of the blood. Calcareous deposits of round, elliptical, cylindrical shapes are also seen in the tissue of the pulp (figs. 582 and 583).

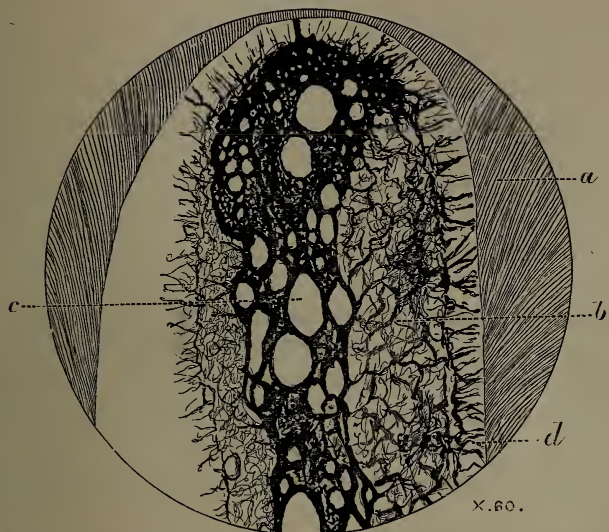

FIG. 584.—(Transverse section.) (*a*) dentine; (*b*) reticular pulp tissue; (*c*) areolæ; (*d*) degenerate odontoblasts.

FIG. 585.—(Longitudinal section.) (*a*) dentine; (*b*) reticular pulp tissue; (*c*) degenerate odontoblasts; (*d*) fibrous cylinder.

In the sections shown (figs. 584 and 585) the cellular elements of the pulp are totally absent.

(2) Fatty Degeneration.—This is usually seen in the pulps of senile teeth, and in teeth which have been treated with the view of retaining the pulp alive. To the naked eye, the pulp is diminished in volume and is of a pale reddish-grey colour with traces of yellow. Occasionally it is of a cheese-like consistency, while in very advanced conditions a soft greasy mass is present in the pulp chamber. According to Wedl, this mass is composed merely of a dirty brownish-yellow detritus, with traces of a fibrous structure, together with clusters of stellate fatty-acid crystals. In pulps which are the subject of fatty degeneration, reaction to thermal stimuli is much diminished and, in advanced cases, quite lost.

Microscopical Appearances.—The odontoblasts appear degenerated and form a layer upon the surface of the pulp. The parenchyma of the pulp contains fat globules which form chains and follow the course of the vessels and nerves. The medullary sheath of the nerves and walls of the vessels also undergo degeneration.

Treatment.—Removal of the pulp and, subsequently, filling of the pulp canals.

(3) Calcareous Deposits.—Calcareous deposits are frequently met with in pulps which have been the seat of inflammatory reaction. These deposits must be carefully distinguished from adventitious dentine, that is, the addition of fresh dentine to the original boundaries of the pulp chamber. Calcareous deposits are occasionally met with in apparently healthy pulps, and it is doubtful if they are, in such cases, of pathological significance.

The simplest form of calcareous deposit is a small pulp nodule. On examination of the tooth after its extraction, these nodules are just visible to the naked eye, and under a low magnifying power, are seen to be concentrically laminated; in some, not fully calcified, the central portion presents an irregular appearance. Pulp nodules are formed near the periphery of the pulp, and, though developed in its tissue, eventually become included in any secondary dentine that may be formed, the dentinal tubes bending round the nodule. Fig. 586 represents two small pulp nodules from the tooth of a child, aged 14, which was removed for irregularity. In fig. 587 the pulp nodule is seen to be projecting from the wall of the canal, having become enclosed by the new formation of dentine. In the coronal pulp of the molars, the nodules reach a much larger size, and, viewed under a very low magnifying power, are seen to be lobulated in outline; on section many are apparently composed of a number

of small nodules joined together by a structureless material (fig. 588). These pulp nodules occur amongst the tissues of the pulp, and must be differentiated from calcification of the tissues of the

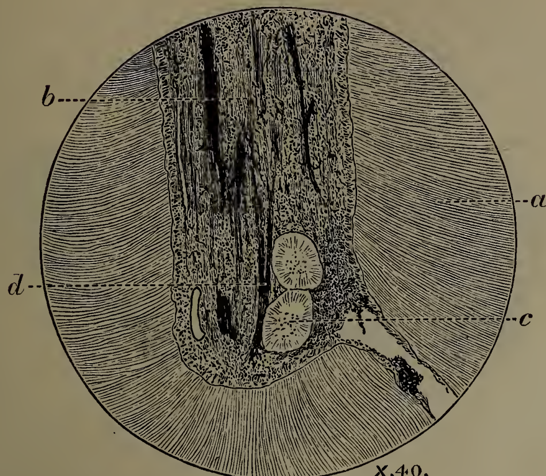

FIG. 586.—Pulp nodules (longitudinal section). (*a*) dentine; (*b*) normal pulp tissue; (*c*) pulp nodules; (*d*) nerve bundles.

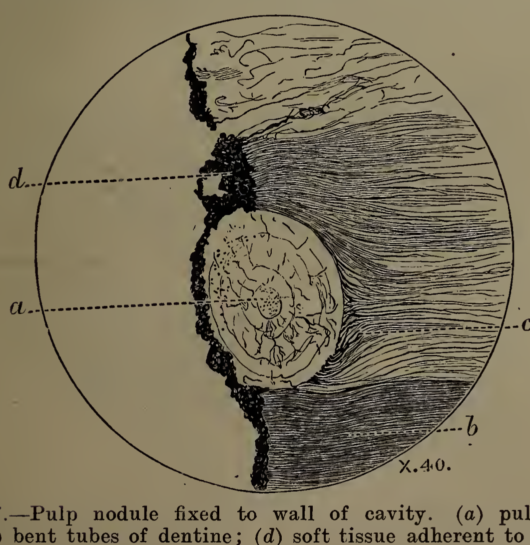

FIG. 587.—Pulp nodule fixed to wall of cavity. (*a*) pulp nodule; (*b*) dentine; (*c*) bent tubes of dentine; (*d*) soft tissue adherent to specimen.

pulp. Black considers that the deposits of calcoglobulin bear some relation to the formation of pulp nodules.

A curious form of *calcareous deposit* is frequently seen *in the*

roots of molars. To the naked eye, the pulp is stiff, retaining its shape when removed from the canals and resuming its shape after being bent. To the touch the pulp feels gritty; under the microscope it is found to be fibrous in character, the cellular elements

Fig. 588.—Semi-diagrammatic.

having to a great extent disappeared, while lying parallel with the fibres and attached to them are little cylinders of calcareous material (fig. 589). In advanced stages the cylinders coalesce, being jointed in an irregular manner. Under such conditions there is an obliteration of the cells, nuclei and connective tissue of the pulp.

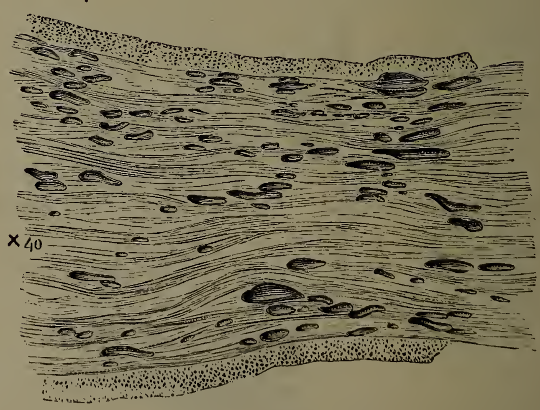

Fig. 589.

The whole tissue of the pulp may undergo calcification (fig. 590). To the naked eye the deposit differs from the pulp nodule in being non-nodulated. It is, as a rule, regular in outline and presents a smooth surface. Microscopically, the appearances vary. In some the calcified tissue element of the pulp is apparent, others appear

granular on section with a few irregular tubes scattered here and there, while others exhibit virtually no structure at all.

(C) EXCEPTIONAL PATHOLOGICAL CONDITIONS

There are a few exceptional pathological conditions of the pulp which have from time to time been described, but the nature of which is by no means clear. Under the title of "Pink Spots on

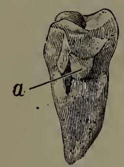

Fig. 590.—(*a*) calcified pulp.

Teeth," J. A. Fothergill[1] records a case in a female, aged 19, "where the maxillary central incisor presented on the labial surface a pink spot, commencing near the upper termination of the mesial border and extending about one-third across the tooth" (fig. 591). The enamel over this portion of the tooth appeared to be very thin,

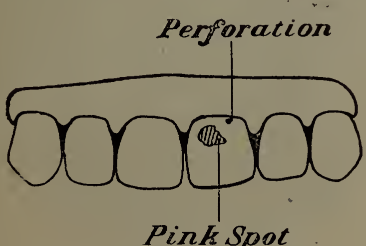

Fig. 591.[2]

and the pink colour to be due to some vascular body showing through.

To the left of the pink spot, and quite near the gum margin, there was a very minute perforation of the enamel, in which soft tissue could be seen. This tissue was slightly sensitive. The edges of the perforation were quite thin and fragile, and gave the impression that absorption had taken place. There was not the slightest sign of caries about the tooth, which was quite firm,

[1] *Trans. Odonto. Soc.*, vol. xxxii, p. 213.
[2] From *Trans. Odonto. Soc.*

and, with the exception of the above described peculiarities, perfectly healthy in appearance. The patient first noticed the discoloration about a month before being seen. There was no pain, but slight tenderness on biting hard substances and when brushing the teeth. There was no history of injury. Rather more than three weeks after the patient was first seen, the perforation was considerably larger, the pink spot had also increased in size, and there were two minute perforations of the enamel within its area. On removing the thin bridge of enamel from between the perforations, a mass of vascular tissue was disclosed which was directly connected with the tooth pulp.

Sections of the tissue showed a structureless mass of small cells, but in one part the section showed papillæ covered with epithelium (see figs. 592 and 593).

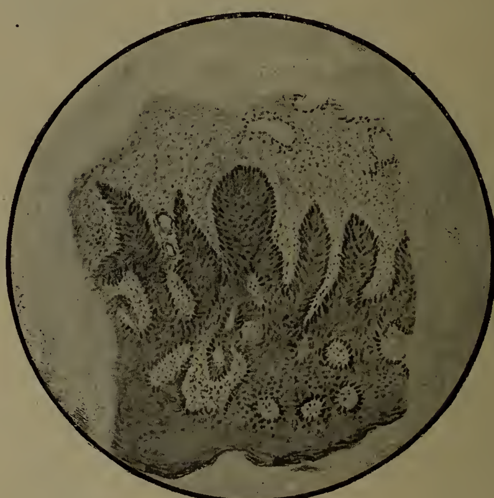

FIG. 592.[1]—Zeiss, ½ obj., 3 oc.

Subsequently, the right central showed signs of a slight rosy tinge at the gum border, and examination of the tooth disclosed, about a quarter of an inch above the gum margin, a tiny cavity, which communicated with the pulp.

A similar case came under my own notice. The tooth affected was the left maxillary central incisor, and there was a small opening in the mesio-labial aspect of the root about an eighth of an inch above the enamel margin. The fleshy point projecting from the opening was exquisitely sensitive and proved to be directly connected with the pulp.

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[1] From *Trans. Odonto. Soc.*

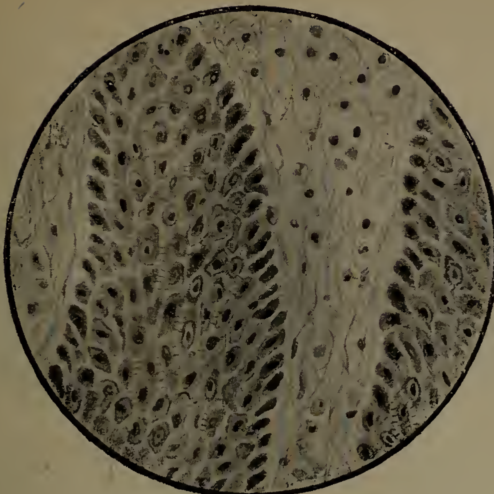

FIG. 593.[1]—Zeiss, $\frac{1}{2}$ obj., 4 oc.

The case recorded by Salter[2] would seem to belong to this group. The tooth was a mandibular molar and showed three small

FIG. 594 (Salter).

[1] From *Trans. Odonto. Soc.*

[2] "Dental Pathology and Surgery," p. 79.

openings just below the edge of the enamel. These canals were short and horizontal, and connected with the interior of the tooth. Sections through the tooth showed that a considerable portion of the dentine had been absorbed and replaced by bone (fig. 594).

Fig. 595.

Teeth are occasionally met with in which a channel exists between the pulp and the periodontal membrane. An example is shown in fig. 595. The tooth was a mandibular first premolar.

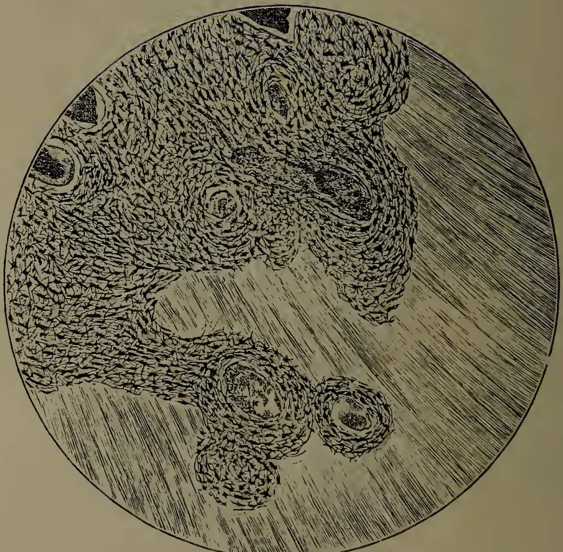

Fig. 596.

Lepkowski[1] has shown that in rare instances there are, in the embryo, anastomoses between the pulp vessels and the vessels

[1] *Die Vierteilung der Gefässe in den Zähnen des Menschen* (Anatomische Hefte), H. liv.

external to the tooth germ, and it seems likely that these anastomoses may occasionally persist and give rise to the abnormality shown in fig. 595.

Fig. 597.[1]—View of the exterior of the tooth showing the pitted character of the end of the root with an excavation running a little way up on one side.

Fig. 598.[1]—View showing position of the carious cavity.

Fig. 599.[1]—Longitudinal section showing the general relation of the new tissue to the pulp cavity.

Fig. 600.[1]—View showing the extension of the new tissue upwards into the dentine by the sides of the pulp cavity.

Another interesting pathological condition is to be found in cases of absorption of the dentine from within outwards, and the replacement by tissue of an osseous type. In one case recorded,[2] the

[1] From *Trans. Odonto. Soc.*

[2] *Trans. Odonto. Soc.*, vol. xxv, p. 66.

dentine in a maxillary premolar had been replaced by bone, the greatest changes being towards the base of the tooth. This tooth was removed from a man, aged 33, and had only partially erupted, the root being only about two-thirds formed (fig. 596). In another specimen, a misplaced unerupted third molar had been the seat of suppuration. In this specimen there was extensive absorption of the dentine and redeposition of bone.

Hopewell-Smith[1] figures a maxillary central incisor, showing internal absorption of dentine and deposition of bone; and C. S. Tomes[2] records a similar condition in a maxillary premolar which had become loose. Views of the latter tooth are shown in figs. 597 and 598, and sections showing the extent of the absorption of the dentine and replacement by bone in figs. 599 and 600.

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[1] "Histology and Pathology of the Teeth," p. 382.

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CHAPTER XVI

Operations connected with the Pulp and Pulp Canals

The Operation of "Capping"—Devitalization of the Pulp—Mummification of the Pulp—Immediate Removal of the Pulp—The Treatment of Septic Pulp Canals—Methods of Bleaching Teeth

(A) WHEN THE PULP IS NOT EXPOSED

In deep cavities where it is intended to insert a metallic filling, the floor should be covered with a layer of non-conducting material such as oxysulphate of zinc. The same procedure should always be adopted in any cavity where the dentine appears to be unduly sensitive.

(B) WHEN THE PULP IS EXPOSED AND LIVING

(1) The Operation of "Capping"

In performing this operation attention must be paid to the following points: (*a*) To render the parts thoroughly aseptic; (*b*) to use a cap of non-irritant material; (*c*) to insure juxtaposition between the cap and its contents and the pulp; (*d*) to avoid pressure upon the pulp; (*e*) to prevent the conduction of thermal changes to the pulp.

The best mode of procedure in capping is as follows: Stop all bleeding from the pulp by syringing with hot water, swab out the cavity with a solution of a mild, unirritating antiseptic, and carefully dry the cavity. Mix a thin paste of the powder of the oxysulphate of zinc and oil of cloves, introduce it into the concave side of the cap, and place it in position over the exposed pulp, care being taken that the margin of the cap rests upon the dentine and not on any part of the exposed pulp. Hold the cap in position with an instrument and then fill the cavity with gutta-percha or some plastic filling. The cap employed may be made of metal. Caps can be easily constructed by cutting out with scissors a circular piece of the material used and giving it a "cup-shape" by pressing upon it with the butt end of an excavator. At times it is very

difficult to get the cap into position, especially with the conveying forceps. The difficulty may be overcome by punching a small hole in the cap so that the little flap formed by punching will be on the convex side of the cap, and if this flap is held with the conveying forceps, the cap may be easily conveyed to the cavity and kept in position. The flap will resume its place with the slight pressure used in filling the remainder of the cavity.

(2) Devitalization of the Pulp

(*a*) **Application of the Drug.**—For devitalizing the pulp, arsenious acid is used, either alone or in combination with other substances. About one-sixteenth of a grain will suffice. The objection to the use of arsenious acid is the pain caused during its action. The pain can be alleviated by employing sedatives with the arsenic and by avoiding pressure on the pulp. The following preparation will be found useful:—

℞ Acidi arseniosi
Cocainæ hydrochlor. } āā
Acidi carbolici glacialis
Misce, et fiat pasta.

The mode of application is as follows: The cavity is opened up and all débris syringed out with warm water. The carious dentine is next removed. It is not always possible to remove all the carious tissue owing to the pain caused, but the portion bordering the edge of the cavity and the part covering the pulp must be removed and a free exposure obtained. It is important that the pulp should be freely exposed, as the resulting hæmorrhage relieves congestion and prevents discoloration of the dentine. The cavity should next be syringed with warm water and measures taken to exclude moisture during the subsequent steps. The cavity should then be dried and the pulp and adjacent dentine disinfected. The dressing is next applied in close contact to the pulp, and over the dressing a concave cap of metal is placed. The cap should be large enough to cover the dressing without pressure, and to allow the edges to rest on the dentine. The cavity is then sealed with gutta-percha or oxysulphate of zinc.

In applying arsenious acid on the approximal surfaces with the cervical margin near the gum there is a risk of the dressing shifting during the introduction of the filling material. In such positions it is best to commence by placing a rim of gutta-percha along the cervical margin beforehand. A small pit will thus be formed and the arsenious acid can then be applied without any risk of the dress-

ing shifting. Fig. 601 explains this point diagrammatically. In cavities in isolated teeth where there is a danger of the dressing not being retained, an elastic band or silk ligature passed round the tooth will be found useful.

Arsenious acid, even with the precautions suggested, may cause great pain during its action. When necessary, counter-irritation to the gum in the form of poultices should be tried. In applying the poultice, contact with the tooth must be avoided. If the poultice is not effective a sedative, such as "aspirin" in 10-grain doses, should be administered.

The time during which an arsenical dressing should be retained depends on the vascularity of the pulp. In acute inflammation

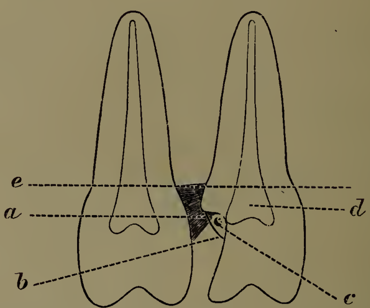


Fig. 601.—(*a*) gutta-percha; (*b*) metal cap covering dressing; (*c*) dressing of arsenious acid; (*d*) pulp chamber; (*e*) line indicating margin of gum.

twenty-four hours is usually sufficient, with chronic suppurating pulpitis thee to four days, while the dressing may remain for at least a week when a fibroid or calcareous condition of the pulp is present. If used for deciduous molars the arsenical dressing should be applied in the morning and removed in the afternoon. If allowed to remain for twenty-four hours there is always a liability of peri-odontal complications.

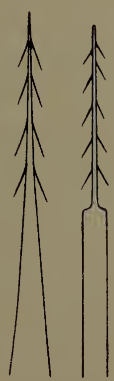
Discoloration of the dentine may follow the application of arsenical dressings, and is not always preventable. The precautions to be taken are to relieve congestion of the pulp as far as possible, and to avoid applying the dressing until the bleeding has completely ceased.

(*b*) **Removal of the Pulp.**—Before attempting the removal of the pulp, the pulp canals must be freely exposed,[1] and the prepara-

[1] For the methods of opening up the pulp canals in the various teeth, see p. 381.

tion of the cavity finished; all débris should then be removed and precautions taken to exclude the saliva. The pulp chamber is then disinfected, and during the subsequent operation the canals and other parts must be kept free from infection. The extracting instruments should be made of fine spring tempered steel of the shape shown in fig. 602. The shoulder shown in fig. 603 is a source of weakness. The instrument should be insinuated up the side of the canal until the apex is reached, then rotated four or five times before retraction is attempted. It is important that the pulp tissue should be completely removed from the canals.

Fracture of the pulp extractor may occur in the canal. If the broken portion is near the orifice it can usually be easily removed. If the fracture has occurred well up the canal, an attempt may be made



(Diagrammatic.)

Fig. 602. Fig. 603.

to entangle it with another barbed extractor, or, failing this, a wisp of cotton-wool on a fine broach may be used. Where the broken portion cannot be removed, a dressing of tinct. iodi. inserted in the canal will have the effect of rusting the steel so that its removal at a subsequent visit can be easily accomplished. Instruments broken in very fine canals should be allowed to remain, as they seldom cause trouble unless they pass through the apical foramen.

It may happen that a small piece of pulp tissue remains alive near the apex of the canal and gives great trouble. In such a case the tissue may be removed after being destroyed by an escharotic. Great care must be taken to distinguish a small piece of pulp from a large apical foramen. If any doubt exists, it is better to treat

the case as one of a large foramen, as the escharotic treatment is liable to injure the periodontal membrane.

(*c*) **The Treatment and Preparation of the Root Canals Preparatory to Filling.**—Any hæmorrhage which may have followed the removal of the pulp must be arrested, and the canals dried as far as possible with cotton-wool. A solution of peroxide of hydrogen should then be passed into the canals, and the surfaces of the dentine scraped with a barbed instrument with a view of removing any shreds of pulp tissue that may remain. The peroxide is then removed and an antiseptic solution introduced—for example, perchloride of mercury 2 per cent. in absolute alcohol. This will assist dehydration. The canals can then be dried with a blast of hot air. By these means the greater part of the canal can be dried, and the portion near the apex may be treated with a root canal drier. The canal having been thoroughly dried, the root filling is introduced.

Considerable discussion has taken place during the last few years as to the *advisability of employing coagulants in the treatment of root canals*. Certain authors think that the coagulants are self-limiting in their action, and do not penetrate the dentinal canals to any great depth. They are of opinion that a coagulum is formed only at the orifice, and that the coagulum effectually prevents deeper action and complete sterilization of the dentine. Against this statement it may be maintained that there is no proof that the contents of the tubes in the pulpless teeth are coagulable, but even if they are, the experiments of Kirk,[1] York[2] and Truman[3] furnish conclusive evidence that coagulants do penetrate the dentinal tubes. Kirk expresses a strong belief in the use of chloride of zinc, which he considers the best agent to procure an unchangeable condition of the contents of the tubules. If the apical foramen is large, a 10 per cent. solution should be employed; if fine, the strength of the solution may be 40 per cent.

The use of drills for enlarging the canals is seldom required in cases where the pulp has been devitalized or immediately removed. The canals in nearly all teeth are large enough to admit of easy filling, and, with drills, there is always the danger of forcing foreign

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1 "On Coagulation in the Treatment of the Pulp Chamber and Canals," *Dental Cosmos*, March, 1894, p. 181.

2 "The Diffusibility of Coagulants in Dentine," *Dental Review*, 1897.

3 "The Relative Penetrating Power of Coagulants," *Dental Cosmos*, January, 1895, p. 33.

matter through the apex in addition to the chances of breaking the drill in the canal. Drills are useful where calcification of the pulp has occurred.

(*d*) **Filling the Canals.**—For filling root canals, a large number of different materials are available, the chief being gutta-percha, osteoplastics, wood, and wire.

In filling a root canal the chief point is to plug the apex thoroughly. *Gutta-percha* is the material favoured by many operators. It is sold ready for use by the various depôts. The method of employing it is as follows: With cotton-wool wound round a broach, introduce some chloro-percha up the root or root canals, using a slight piston-like action; then pass a gutta-percha point up the canal as far as the apex, and by the side of it introduce one or more points as may be required. The points should then be left in position for about half a minute, after which, with suitable instruments, they should be condensed and thoroughly packed into the canal. On introducing the first point a slight twinge of pain will occasionally be felt. This generally indicates that the gutta-percha has passed through the apex owing to the point being too small, but it may also be due to air being forced through the apex. To meet this difficulty, remove the gutta-percha and cut off the end and re-introduce. It is a little troublesome at times to hold the points of gutta-percha in the forceps in a suitable position, but if the points of the forceps are slightly warmed the gutta-percha adheres to them, and can be easily carried to any situation. The canals being filled, the remainder of the pulp chamber should be filled with osteoplastic cement, so that, if anything goes amiss with the filling in the cavity, the osteoplastics will protect the gutta-percha in the canals and prevent them becoming septic.

Gutta-percha for canal fillings answers satisfactorily in all but very small canals, and it is found quite easy to get it to the apex. An argument against its use is that it is liable to become septic, but if the canals are cleansed properly and filled there should be no danger in that direction.

The osteoplastics make excellent root canal fillings. They can be introduced into the canal as follows: Loosely wrap a wisp of cotton-wool round a broach and pass this into a moderately thin mix of the filling, then insert into the cavity. A minimum amount of wool should be used and the filling forced up the canal with a slight piston-like action. Of the osteoplastics, oxychloride possesses marked antiseptic properties and sets rapidly, but it is liable to irritate the periodontal membrane. Oxysulphate makes a good filling and the following mixture gives excellent results:—

Oxide of zinc
Sulphate of zinc } āā ℨij.
Loretin

Mix into a paste of creamy consistency with solution of gum-arabic.[1]

Wood is useful in small canals and can be obtained from the depôts ready for use. The *modus operandi* is as follows: The length of the canal having been obtained, a peg is selected which fits loosely in the canal. The canals should then be swabbed with the mixture suggested above, and the peg then forced into position. A rotary motion is then given to the wood peg, and this causes the portion in the canal to break off. An argument urged against wood is that it is liable to expand from absorption of moisture and split the tooth. To avoid this contingency, the points should be well soaked in paraffin during the process of manufacture. Wood as a filling for root canals has the great advantage of being easily passed to the apex of the canal, and is capable of being introduced into the finest canals.

(*e*) **The Treatment of Difficult Canals.**—Two classes of canals come under this heading:—

(1) Very small canals in normal-shaped roots.

(2) Canals in twisted and curved roots.

Included in the first group are the canals in—

(i) The maxillary premolars, especially the first where two canals exist instead of one.

(ii) The buccal roots of the maxillary molars.

(iii) The mandibular incisors.

(iv) The anterior roots of the mandibular molars, especially the first.

(v) Canals narrowed by secondary dentine.

If these canals can be cleared with a fine instrument, but are not large enough to permit of treatment with drugs, the following procedure may be adopted: Absolute alcohol containing 2 per cent. of perchloride of mercury is introduced as far up the canals as possible and the canals dried with a blast of hot air. No attempt to fill the roots should be made, but little pellets containing oil of cinnamon and perchloride of mercury should be placed over the orifices.

For the treatment of small canals, Callahan (*Dental Cosmos*, 1895) recommends *the use of sulphuric acid* 30 per cent., and his method has been warmly advocated by many, including Bönnecken. A drop of the sulphuric acid is conveyed to the orifices of the canals

[1] Loretin unfortunately is liable to stain the teeth, and it is therefore better to employ it only for filling canals in the premolars and molars.

and gradually worked in by the aid of fine bristles. The acid dissolves the lime salts, forming calcium sulphate, and so enlarges the canal. Sodium peroxide is next introduced into the canal. The sodium peroxide in the case of putrescent canals forms soap, and destroys the fatty contents of the canal, and the rapid evolution of H_2O_2 ejects the contents into the pulp chamber.

$$H_2SO_4 + Na_2O_2 = Na_2SO_4 + H_2O_2$$

The latter is in a nascent condition, and effects prompt sterilization. The procedure of alternately using the sulphuric acid and sodium peroxide is repeated until the canal is quite clear. By this method it is possible to cleanse and fill canals which by the ordinary treatment are inaccessible. Pumping the acid through the apex must be avoided.

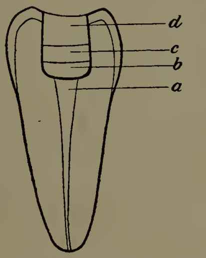

FIG. 604.—(*a*) devitalized pulp; (*b*) mummifying paste; (*c*) osteoplastic cement; (*d*) metal filling.

J. P. Buckley prefers phenolsulphonic 80 per cent. in place of sulphuric acid, the former being thick and syrupy and therefore more easily carried into the pulp canals.

In twisted and tortuous canals the pulp is to be removed as far as possible, and one of the methods suggested for mummifying the pulp should be adopted.

(3) Mummification of the Pulp

This operation consists in first applying a devitalizing agent to the pulp, and, at a subsequent visit, removing the coronal portion and applying medicaments to the portions remaining in the root or roots and filling the cavity permanently (fig. 604). It is important that all the stages of the operation should be carried out under strict aseptic precautions.

The following preparation suggested by Söderberg[1] gives good results:—

Aluminis exsiccati, Thymol, Glycerini	āā ℨi.
Zinc. oxid. q.s. to make a stiff paste.	

In this paste the thymol acts as the antiseptic, the alum as the mummifying agent, the zinc oxide as the conveying medium, and the glycerol as the binding and penetrating agent.

Miller suggested a mixture of perchloride of mercury 0·0075 grm., thymol 0·0075 grm., made in the form of little pellets. The perchloride of mercury at times causes pain, and also has the disadvantage of staining the tooth structure, but in the case of posterior teeth the staining is immaterial. With this combination the living portions of the pulp are rapidly killed by coagulation of the cell protoplasm and then impregnated with the sublimate and thymol and so sterilized. H. Bönnecken[2] has devoted attention to this question and gives an account of two cases in which he was able to make a microscopical examination. He found the pulps in a state of fatty degeneration, globules of colloid and calcareous matter being present in the bundles of connective tissue, and the capillaries thrombosed. He suggests the following preparation, and carries out the treatment forty-eight hours after the application of the arsenical dressing:—

℞ Cocainæ, Thymol	āā ℨi.
Misce exactissime terendo et adde—	
Formaldehydi soluti (40 per cent.) ...	♏xl.
Zinci oxidi	ℨii.
Misce. Fiat pasta.	

When cocaine and thymol are rubbed together in the mortar they deliquesce, taking up moisture from the air. Therefore, after the addition of ten drops of formalin a relatively large amount of oxide of zinc must be added to give the mixture the consistence of a paste. Bönnecken finds that the preparation does not give rise to pain and that there is no discoloration. With a stronger percentage of formalin pain is liable to occur.

Pulp mummification is useful in (*a*) fine canals from which the pulp cannot be removed; (*b*) nervous and weak patients unable to undergo tedious root filling; (*c*) canals which are twisted and tortuous.

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[1] *Dental Cosmos*, November, 1895, p. 922.

[2] *Oesterreich-Ungarische Vierteljahrsschrift für Zahnheilkunde*, vol. xi, &c. Translated in *Dental Record*, vol. xviii, p. 158.

(4) Immediate Removal of the Pulp

Extirpation of the pulp with the aid of "**pressure anæsthesia**" is now generally adopted. This proceeding is carried out as follows: The cavity is freed of carious dentine as far as possible, and the surface of the pulp uncovered and swabbed with hydrogen peroxide. A small pellet composed of cocaine and adrenalin[1] is then placed on the pulp and covered with a piece of unvulcanized rubber, and lightly pressed. As soon as the immediate pain caused by the application has disappeared the pressure may be gradually increased. Pulps vary considerably in their responsiveness to cocaine. In some cases the application of cocaine for a few seconds is sufficient to produce anæsthesia of the whole pulp, while in other cases it may be necessary for the application to last five or even ten minutes. The amount of anæsthesia can be gauged by passing a broach up the canal. The preparation of the cavity should next be completed and the pulp then removed. The bleeding that usually follows must be arrested and the pulp canals filled at once. Clinical experience shows that trouble is less likely to follow if the canal is filled immediately after the removal of the pulp.

The periodontitis that occasionally follows immediate extirpation of the pulp is probably due to infection, the direct result of the pressure, and is likely to follow in cases where active suppuration is present. This complication may be avoided to a great extent by treating the pulp with an antiseptic dressing for twenty-four hours. Periodontitis may also be due to medicaments being forced through the canal into the peri-apical space.

The removal of the pulp may be also carried out under anæsthesia induced by the regional and infiltration methods.

At this stage the *comparative value of the methods of treating the exposed living pulp* may be reviewed. The operation of capping is uncertain, and should be limited to the treatment of healthy pulps exposed during the preparation of cavities for filling. Extirpation of the pulp under pressure anæsthesia is by far the best method of removing pulps, and the success attending this operation increases with experience. Arsenious acid may with advantage be employed where, owing to nervousness on the part of the patient, it is impracticable to carry out the preliminary stages of pulp extirpation, such as removal of carious dentine, and where pulps contain large deposits of calcareous matter. "Mummification" is useful in cases where, owing to calcareous deposits in the canals, it

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[1] A convenient form is supplied by Messrs. Parke, Davis and Co. Each pellet contains $\frac{1}{6}$ gr. of cocaine hydrochlorate and $\frac{1}{300}$ gr. of adrenalin.

is impossible to clear them of pulp tissue. It may be said with truth that each of these four methods has its use in its proper place.

(C) WHEN THE PULP IS DEAD

If the contents of the pulp cavity in which the pulp is dead be examined, they will be found to vary according to the pathological conditions that have caused the death of the pulp.

(i) The gangrenous pulp may be entire, or may have undergone disintegration, leaving the contents moist and in a sloughing condition, which, in most instances, terminates in complete disorganization.

(ii) The contents may be dry and granular.

(iii) The pulp tissue may be transformed into a cheesy mass. This condition, which is probably due to a form of fatty degeneration, is often found in those pulps which have been "capped" or have died under fillings.

The treatment of pulpless teeth is a matter of great practical importance, and opinions are divided as to which is the best method to adopt. The successful treatment of a tooth with a septic pulp cavity depends upon:—

(1) The thorough removal of the contents of the canals.

(2) The sterilization of the tooth tissues.

The first step in treatment should be the removal of the carious dentine, followed by the insertion of a dressing to sterilize as far as possible the contents of the pulp canals. The best dressing is cresol mixed with formaldehyde, and it should remain in position for from three to four days.

On the next visit access to the canals should be gained and the preparation of the cavity completed. The rubber dam, or some other method for excluding saliva, should be used, and the cavity, having been dried with cotton-wool, should be swabbed out with peroxide of hydrogen. With hooked nerve extractors the canal should be carefully freed of débris, and in carrying out this part of the operation a word of caution is necessary. There is a danger of septic material being forced through the apical foramen, and to obviate this the cleansing process should gradually proceed from the orifice of the canal to the apex, sodium peroxide followed by peroxide of hydrogen being frequently introduced into the canal to sterilize the pulp tissue and prevent septic inflammation, should any of the pulp tissue pass through the apex. The canals should then be treated with some antiseptic solution introduced on a wisp of cotton-wool, a rotatory rather than a pumping action being employed.

The pulp tissue having been removed as far as possible, the advisability of enlarging the canals with reamers must be considered. The canals should be enlarged in all cases where a septic condition exists. The dentine bordering the canal is the part most infected, and is therefore removed in the process of enlarging. An antiseptic dressing should then be sealed in the canal and left for about one week. At the next visit, if the dressing shows no signs of sepsis, the canal can be filled as described on p. 461.

Schreier has recommended a mixture of *sodium and potassium* for dealing with septic roots. The mixture consists of two parts of sodium to one of potassium, and is used as follows: The cavity is prepared and the pulp chamber opened up so as to allow free access to the root or roots. The rubber dam should always be applied. With a warm instrument an opening is made through the wax covering the mixture. A fine broach—iridio-platinum for preference—is introduced into the preparation and withdrawn; the broach with the adherent mixture is then introduced into the canal. This step is followed by a slight hissing or explosion. One application is usually sufficient for each root, but this depends upon the amount of septic matter in the canal and the quantity of kalium-natrium introduced. "Potassium and sodium hydroxides are formed which, in combination with the fat of the pulp, form soap. A portion of the alkalies renders the albuminous substances in the canal soluble, and in this way tissue adherent to the walls is dissolved and access easily obtained to the dentinal tubes." The kalium-natrium is said to possess germicidal properties, partly by the heat set up and partly by the new product formed. The introduction of the kalium-natrium should be followed by the use of sodium or hydrogen peroxide. In practice the method yields good results, and its use is indicated in canals the contents of which are very putrid.

J. P. Buckley in the cleansing of the canals prefers to work carefully up the canal with phenolsulphonic acid, frequently neutralizing the acid with a solution of 10 per cent. sodium bicarbonate.

In *cases complicated with acute periodontitis* it is important, if possible, to remove the contents of the canals, but this can seldom be thoroughly carried out. An entrance, however, should be made into the pulp chamber. If the tooth is free from caries, or a filled cavity is present, an opening should be made into the pulp cavity by the most direct route, and treatment for acute periodontitis prescribed. If a cavity exists, the pulp cavity should be opened and the contents removed and the canal freely syringed with antiseptics.

The pulp chamber should be syringed daily, and, when the inflammation has subsided, the canals sterilized and filled. In opening up teeth with acute periodontitis much pain may be saved by keeping the tooth steady.

In *cases complicated with suppuration around the apex of the tooth* the canal should be treated as previously described. The abscess cavity should then be opened by trephining through the alveolar process (see p. 477) and the suppurating surface scraped. The abscess cavity should then be packed with an antiseptic gauze and made to heal by granulation from the bottom of the cavity.

If a sinus is present on the gum a similar line of treatment should be adopted.

(D) THE EMPLOYMENT OF DRILLS IN CANAL TREATMENT

Before using root drills it is well to pass up the canal a fine unbarbed instrument on the shank of which is a small piece of rubber—this will indicate roughly the direction of the canal and its length, the length being marked by the position of the piece of rubber. The drills should be used on the engine. Care should be taken that they are spring tempered, and that when in use, they are in a direct line with the root to be filled. They should be employed with a "touch and go" movement, and persuasion, not force, used, the pointed head of the drill guiding the instrument along. Frequent withdrawals should be made to allow the removal of débris, and the depth to which the drill has gone should be tested with a broach. It is important to start with a small drill at first, substituting larger ones from time to time. The first drill should reach the apex; the larger ones should, however, not reach quite so far. The subsequent treatment of the canals is essentially the same in all respects as that previously described. The use of drills is sometimes attended by accidents.

The causes leading to fracture of drills are:—

(1) Pushing the drill up too rapidly, and thus causing it to become fixed.

(2) Not having a sufficiently large opening into the cavity, and so trying to work the drill round the corner.

Perforation of the apex with a drill is caused by using a small drill with too much force.

Perforation of the side wall of the canal may occur. This is often due to the employment of large drills in small canals—for example, in the maxillary lateral incisors, buccal roots of maxillary molars, &c. It may arise from attempting to drill round the corner,

especially when injudicious force is employed to make the drills advance.

Treatment.—Should the drill break in the canal, efforts should be made to remove it. The canal should be first enlarged and an attempt made to get hold of the broken drill with a pair of forceps specially designed for the purpose. If the attempt fail, a strong barbed instrument should be passed up the canal and an endeavour made to hook down the broken drill. Cotton-wool at the end of a broach to entangle the drill may be tried. If the drill cannot be removed by these methods, it must be left in the canal or rusted out by applications of iodine.

With regard to *perforation of the apex*, the best treatment is to syringe the canal with a solution of peroxide of hydrogen, arrest the hæmorrhage, and then disinfect and fill the canal. When the side of the root has been perforated the tooth should be removed.

(E) METHODS OF BLEACHING TEETH

Pulpless teeth often become discoloured. In some cases the discoloration is hardly perceptible, while in others it is marked, being often of a bluish black. Teeth in which the pulp has died from the effects of injuries seem to discolour most, and the teeth of the young are more liable to be discoloured than those of adults. The discoloration is said by some writers to be due to the passage of the colouring matter of the blood into the dentinal tubes, but until the nature of the product formed in the dentinal tubes is definitely known it is difficult to decide if this view is correct. Staining of the tooth structure may also be due to the use of amalgam as a filling, and this is referred to under Amalgam.

To remedy the unsightly appearance of discoloured teeth the process of bleaching is recommended.

The best results are obtained with hydrogen peroxide (100 vols.). The tooth must be isolated with rubber dam. The drug is placed in the cavity on a pledget of wool and decomposed with an air-blast from the hot-air syringe. The treatment needs to be continued for about a quarter of an hour, when a small amount of hydrogen peroxide may be left in the cavity and the filling of gutta-percha or oxyphosphate inserted. It is well to seal the apical foramen before applying the drug.

In teeth discoloured by metallic stains, little improvement can be anticipated from bleaching. In the majority of cases it is better to remove the discoloured dentine as far as is safe, and then to fill or line the cavity with some light-coloured osteoplastic.

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CHAPTER XVII

Diseases of the Periodontal Membrane

Acute Local Periodontitis—Chronic Local Periodontitis—Acute General Periodontitis—Regressive Changes—Necrosis of Teeth—Granulomes—Anchylosis of the Teeth to the Jaws

(A) LOCAL REACTION TO INJURY; INFLAMMATION—PERIODONTITIS

The local adaptive changes resulting from injury to the tooth membrane are generally known as "periodontitis." Two grades of inflammation may be recognized, namely, the acute and the chronic. In acute periodontitis, the development of the inflammatory processes is rapid, and is accompanied by marked clinical symptoms; in chronic periodontitis, the reaction is slow in development and the clinical signs are either very feebly marked or absent altogether.

(1) Acute Local Periodontitis

Causes.—In a few instances, acute periodontitis may arise from *traumatism*, e.g., a blow; too rapid separation of teeth preparatory to filling; the application of too much force when teeth are being regulated by mechanical appliances; or the passage of an instrument into the membrane during the treatment of the root canal. The commonest cause is injury from the *toxic products of bacteria* which may reach the membrane via the pulp canal or the gingival margin, a good example of the latter being seen in cases of suppuration in connection with partially erupted mandibular third molars. Injury to the membrane leading to acute periodontitis may also arise from the injudicious use of strong *chemical agents* in the treatment of the pulp canal.

Generally speaking, the reaction set up by injury from chemical agents or trauma terminates in "resolution," while the reaction started by the toxic products of bacteria invariably ends in suppuration.

Morbid Anatomy and Pathology.—The primary effect of the injury is to cause a temporary contraction of the arteries, and this

is succeeded by a slow but progressive arterial dilatation which eventually extends to the capillaries. The increased flow of blood to the part causes the tooth to be slightly pushed from its socket, and the result shows itself clinically by the tooth appearing to be too long. The further development of the inflammatory process consists of a slowing of the blood current accompanied by increased outflow of lymph from the vessels and migration of the leucocytes. If the injury is not of a bacterial character, the reaction may not reach beyond this stage, the stasis in the blood-vessels disappears, the fluid exudate passes into the lymphatics, the débris of any dead tissue is removed by the leucocytes and the parts return to their normal condition.

When the injury is bacterial in character, the inflammatory process is characterized by a marked attraction to the part of leucocytes of the polymorphonuclear variety accompanied by a rapid liquefaction and digestion of the tissue elements. A zone of tissue around the tooth is thus destroyed and its place is taken by a cream-like fluid, i,e., "pus." Adami[1] points out that in suppurative inflammation there is a period of incubation during which the bacteria multiply and the migration of the leucocytes to the part does not occur until after the cells of the part have become swollen and the vessels full of blood. The delay in the attraction of the leucocytes is, he thinks, due to the fact that some little time must elapse before sufficient toxins are formed by bacteria to attract the leucocytes. Clinically this is shown about the second day by the rapid development of symptoms following the onset of a septic periodontitis. The bacterial growth continues until the organism is able to offer sufficient resistance, the liquefied tissue, "pus," being walled in by a dense layer of leucocytes, and a fully developed abscess is formed. When the pus has formed it may:—

(*a*) become circumscribed, and the condition become more or less chronic; (*b*) work towards the surface and point; (*c*) burrow along the fascia and the muscles.

When the pus becomes circumscribed, the inflammatory process subsides and a zone of granulation tissue forms around the pus and encloses it. The abscess may then remain inert, but more commonly the suppuration slowly spreads and gives rise to a type of chronic abscess.

When the pus works towards the surface, it follows the direction of least resistance. It may escape at the gingival margin, but in most cases it works its way through the outer alveolar wall and

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[1] "The Principles of Pathology," p. 393.

points on the gum over the affected tooth. As long as the pus is confined in the bone, the muco-periosteum is only slightly œdematous, the cellular tissue of the face being unaffected. But when the pus has gained an exit through the alveolar process a rapid swelling of the cellular tissues takes place owing to a diffuse cellulitis. The extent of the swelling is determined by the virulence of the organisms producing the suppuration and by the resistance of the tissues. The abscess may discharge spontaneously, and, if the tooth or source of infection be removed, healing by granulation usually ensues. In the event of the source of infection remaining, the surface is kept constantly infected and a chronic sinus results.

When the pus burrows along the fascia and muscles, it may lead to troublesome complications.

In the maxilla suppuration around the maxillary central and lateral incisors may spread into the nasal fossa. Pus from the region of the maxillary lateral incisors is prone to burrow under the muco-periosteum of the hard palate and form a large fluctuating swelling which usually points at the junction of the hard and the soft palate. Although this condition occurs most frequently in connection with the lateral incisor, it may arise from the second premolar, the first molar, or indeed any tooth in the maxilla. The pus may take a direction towards the maxillary sinus, invade this cavity and lead to antral suppuration. This occurs generally in connection with the second premolar or the molars, but may arise from any tooth in the maxilla. Infection from the premolars and molars may track upwards to the orbit and set up an orbital periostitis and cellulitis (see p. 674). Infection around the maxillary molars may spread through the posterior dental (posterior superior alveolar) veins to the pterygoid plexus and from the latter infection may pass by way of the emissary veins to the cavernous sinus. This type of case exhibits the following clinical features: Pain around the tooth with the signs of suppuration in the early stage; the infection spreads rapidly and the eyelids become swollen and œdematous; severe pain in the head which becomes extreme with the slightest movement; the patient loses consciousness and passes into a condition of stupor; the head is drawn to the affected side; there may be proptosis of both eyeballs, the temperature rises considerably, and there is increase in the pulse and respiration rate. The prognosis is distinctly bad. Pus around the canine may burrow upwards towards the inner canthus of the eye, and in one case seen, an abscess in connection with the maxillary first premolar pointed near the angle of the mouth.

In the mandible, the pus, instead of working its way through

the outer alveolar plate, may penetrate the inner side of the alveolar process and open on the floor of the mouth. From the incisors and canines, the pus, especially if it penetrates the outer alveolar plate low down, may strip up the periosteum and eventually open under the chin. The insertion of the buccinator will usually influence the direction taken by the pus. If the pus penetrates the bone outside the attachment of the buccinator, it will burrow into the tissues of the cheek, perforate the skin and open on the face. The most severe forms of dento-alveolar abscess arise in connection with the molars. The pus may burrow under the masseter, or under the internal pterygoid and work among the planes of connective tissue in the neck, producing a diffuse cellulitis (*angina Ludovici*). The onset of the cellulitis is attended by a marked increase of the temperature; rigors often occur, and there is great prostration. There is marked œdema of the tissues forming the floor of the mouth, the mucous membrane being pushed up in such a manner that it frequently suggests a second tongue. The swelling increases rapidly over the front of the neck, spreads backwards to the parotid region, upwards to the orbit and, in the later stages, involves the thorax. There is usually œdema of the larynx. The brain may become involved by extension of phlebitis along communicating venous branches. The condition nearly always terminates fatally. A case of extreme severity which, however, terminated favourably, was recorded by A. Kendrick.[1] The trouble arose in connection with a mandibular left first molar which one year previously had been fractured. The left eye was closed, and pus escaped from the lower orbital margin and from the upper eyelid, a large sloughy opening being present in the centre of the cheek. There were several sinuses along the border of the mandible. The pus had travelled down the anterior border of the sterno-mastoid to the clavicle, where several sinuses opened; there was also a large sinus over the sternum. Pus had burrowed upwards along the ramus into the temporal fossa, the whole temporal region being œdematous. The tooth was removed; the temporal region was incised and the sinuses freely opened up and packed with iodoform gauze, the patient making a steady recovery.

Extensive necrosis of the maxilla or mandible may result from dento-alveolar abscess (see chapter XXX). In severe cases general infection may occur.

Acute suppurative periodontitis may arise in connection with

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[1] *Journ. Brit. Dent. Assoc.*, October, 1900.

teeth with living pulps. Two very interesting cases of this character have been reported by A. E. Baker.[1] In one, a girl, aged 13, there was a small cavity on the lingual surface of the right maxillary lateral incisor. The pulp was exposed and a dressing of devitalizing material was applied for half an hour, when the cavity was enlarged and a fresh dressing applied. Five days subsequently the patient returned with a large dento-alveolar abscess pointing in the sulcus between the gum and the upper lip. The abscess was opened. The next day the dressing in the cavity was removed and the cavity left open to allow the abscess to drain, the assumption being that the pulp was dead. When seen five days later the abscess was apparently cured, but the pulp was found to be partially alive. It was removed and the canal filled. The second case was in connection with a maxillary left second premolar distal cavity. Remnants of pulp remained at the apices, and to these arsenic was applied. A mesial cavity in the first molar was prepared and a layer of softened dentine left over the pulp. A dressing of sandarac varnish was packed into the cavities to press away the gum. After two days the patient returned, and it was found that a large abscess had formed. The pulp of the molar was acutely sensitive and arsenic was applied. The root canals of both teeth were subsequently cleared and filled. In both these cases, Baker considered that the periodontal membrane had probably been infected via the living pulp.

Signs and Symptoms.—In the early stage, the tooth causes the patient discomfort, is slightly raised in its socket, and pressure brings relief. At this period, the blood-vessels are in a condition of hyperæmia. The tooth then becomes still further elongated and loose, the gum around it being swollen and painful. The vessels are nearing the condition of stasis, and the surrounding tissues are infiltrated with inflammatory exudation, hence the increased rising of the tooth in its socket. Pressure now increases the pain, because the vessels can no longer be freed of their surplus supply of blood. Each act of mastication under such conditions only increases the pressure on the already hypersensitive nerves. If suppuration supervenes, the swelling of the gum increases, the tooth becomes more loose and the pain dull and throbbing. Finally, a distinct fluctuating swelling appears in the sulcus between the gum and the cheek, the face swells quickly, and, the pus being no longer confined in a dense unyielding structure, the tension upon the nerve-endings

[1] *Journ. Brit. Dent. Assoc.*, May, 1895, p. 268.

is relieved and the pain considerably lessened. Suppuration is usually accompanied by pyrexia.

Diagnosis.—The diagnosis is usually easy. Where suppuration has taken place, the surrounding teeth may have become implicated in the inflammation, but the tooth causing the trouble will be looser than its neighbours and more sensitive to pressure and percussion.

Treatment. *Local.*—The first step is to remove the cause, as far as this is practicable. If the condition is due to the passage of drugs through the apex of the tooth, the application of counter-irritants or fomentations to the gums will usually give relief. Where the injury has been caused by instruments in the treatment of the root canal, an attempt may be made to retain the tooth by sterilization of the canal and the insertion of a non-irritating root filling, but teeth which have been injured in this way seldom recover completely.

When the periodontitis is due to bacterial toxins, the first point to decide is whether the retention of the tooth is advisable. Teeth that are unsavable by conservative operations should be removed. Where there is a possibility of retaining the tooth, the septic matter in the pulp chamber should be removed. Care should be taken in performing this operation, as such teeth are extremely sensitive. The tooth should be kept as firmly fixed as possible. Although complete removal of the septic matter is seldom practicable, an effort should always be made to gain an entrance to the pulp chamber and for this purpose a small hole should be drilled through the tooth at the neck. This can be accomplished with a sharp bur without causing much pain. The pulp chamber should be syringed with an antiseptic solution. Fomentations should be applied to the gum over the root of the tooth, or the gums may be scarified. *If suppuration has occurred*, measures must be taken to remove pus as soon as possible. The removal of the pus may be hastened by the continued application of fomentations over the situation of the tooth, and, as soon as the pus has pointed, the abscess should be opened. The cavity should be thoroughly irrigated with some unirritating antiseptic solution and drainage provided. The abscess should be dressed at least twice a day, and this is especially needful when it occurs in the mandible, as the opening is not then in the most dependent part. Acute dento-alveolar abscesses generally heal rapidly, especially if carefully dressed. In the case of extensive abscess, the patient must be anæsthetized, the suppurating tracts freely opened, irrigated, and packed with an antiseptic gauze; but this is a subject belonging rather to the domain of general surgery.

If the skin shows signs of being involved in the inflammatory

process, it should be dressed with a compress dipped in some mild astringent solution (lotio plumbi). If the abscess threatens to open through the skin, the latter should be supported by covering the surface with a layer of cotton-wool painted over with collodion solution; by this means, aided by free opening of the abscess into the mouth, the opening on the surface can often be avoided. When an opening through the skin is unavoidable, an incision should be made at the earliest opportunity, and on no account should the abscess be allowed to burst spontaneously. If this precaution is taken, much disfiguration may be avoided. The incision should follow, as far as possible, the fibres of the platysma. A cut across the fibres leaves a gaping wound, whereas when the cut is parallel with them the resulting scar is almost imperceptible.

When the patient will consent, a much better course is to open the apical space through the alveolar process. An anæsthetic having been administered, an incision is made in the gum down to the bone. The hæmorrhage is arrested, the periosteum covering the part to be penetrated is raised, and the apical space opened with a trephine on the dental engine. The cavity is then syringed and the opening packed with an antiseptic gauze.

In opening an abscess connected with a mandibular molar, care must be taken to avoid injuring the artery. In cutting, the knife should be directed towards the bone and not away from it. In opening abscesses in the palate, the anterior or posterior palatine arteries may be injured. The incisions into palatal abscesses should therefore be made, as far as possible, parallel with the course of these vessels.

As soon as the active stage of inflammation has subsided the pulp canals should be treated in the usual way. *Where suppuration is extensive* and the pus shows signs of burrowing in an unusual direction, the tooth should be removed immediately.

General.—In the early stages a smart saline purge will assist in clearing up a local periodontitis. If suppuration has taken place, the necessity of attending to the general health of the patient cannot be too strongly insisted on. The bowels should be carefully regulated, and, if needful, a tonic treatment prescribed which, in addition to drugs, should include plenty of fresh air and good wholesome nourishing diet.

(2) Chronic Local Periodontitis

(i) Commencing near the Apex of the Tooth

Causes.—Chronic periodontitis follows on injuries similar to those leading to the acute form, the difference in the reaction of the

tissues being due to the lesser intensity and persistence of the injury. By far the larger number of cases arise from infection via the pulp canal. In a few instances, the injury may be caused by the passage of a root filling through the apical foramen. Malocclusion or excessive use may also be cited as causes.

Morbid Anatomy and Pathology.—Where the injury is of slight intensity the change which occurs consists in a proliferation of the connective tissue leading to a thickening of the membrane, the

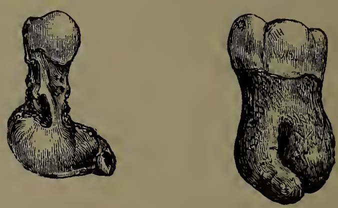


Fig. 605.

portion immediately adjacent to the tooth tissue being replaced by cemental tissue. This type of reaction is termed *proliferative periodontitis.* The process is analogous to that which occurs in a proliferative periostitis. The naked-eye appearances of the tooth are shown in fig. 605. When the inflammation is continuous and productive, the surface of the new tissue usually presents a smooth appearance, as seen in fig. 606. On the other hand, when the condition alternates between a productive and a rarefying periodontitis,

Fig. 606.

Fig. 607.

an irregular outline is usually seen, as in fig. 607. Sections through the hard tissues of teeth showing this condition are shown in figs. 608 and 609. It will be noted that in fig. 608 the original layer of cemental tissue is intact, and that the lacunæ of the new tissue are fairly regular, the incremental lines of Salter being well marked. These lines are situated at the junction of the laminæ. The lacunæ in the new tissue are more numerous and are also slightly larger and coarser than in normal cementum.

Simultaneously with the formation of the cemental tissue, a rarefying osteitis occurs, which makes room in the tooth socket for the new tissue (fig. 610). In extreme cases, two or more teeth may

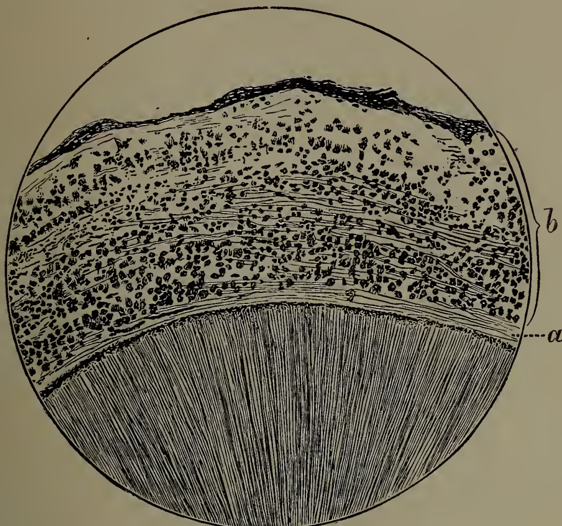


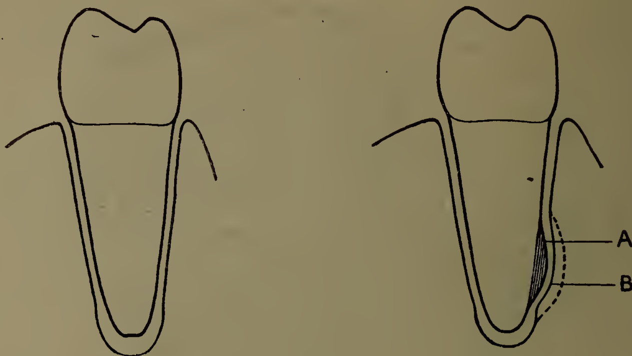
FIG. 608.—(*a*) Original layer of cementum; (*b*) tissue of new formation.

FIG. 609.—Longitudinal section showing new tissues. (*a*) dentine; (*b*) new tissue; (*c*) granular layer.

be the subjects of proliferative periodontitis; the intervening septum of bone may be completely removed by a rarefying osteitis and the

teeth become united by cemental tissue. This occurred in the case shown in fig. 611.

The new tissue is often more irregular in character than that shown in fig. 608, the laminæ being absent and the lacunæ placed irregularly (see fig. 612). Vascular canals are at times seen.

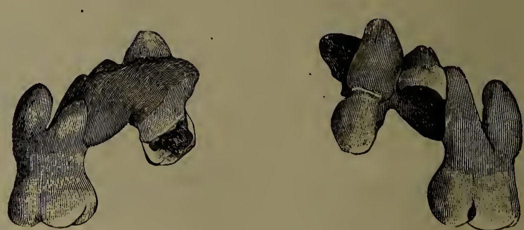


(*a*) Showing normal relation of tooth to the alveolar process.

(*b*) Showing changes which occur in productive periodontitis. (A) new tissue; (B) zone of rarefying osteitis.

Fig. 610.

Adami has pointed out that substances which in larger quantities are toxic and lead to degeneration of the tissues often in smaller quantities act as direct stimuli to the cells and to increased growth; that is to say, the increased growth is not secondary to



(*a*) (*b*)

Fig. 611.

tissue destruction. Mechanical stimuli, or irritation, result in similar overgrowth.

Where the intensity of the injury is greater, the reaction in the tissues is characterized by cell infiltration of the parts in addition to the cell proliferation of the connective tissues. Among the latter

are multi-nucleated cells (osteoclasts) which absorb the tooth tissue. This type of reaction is termed *rarefying periodontitis*, and the process is analogous to rarefying osteitis. A section through the

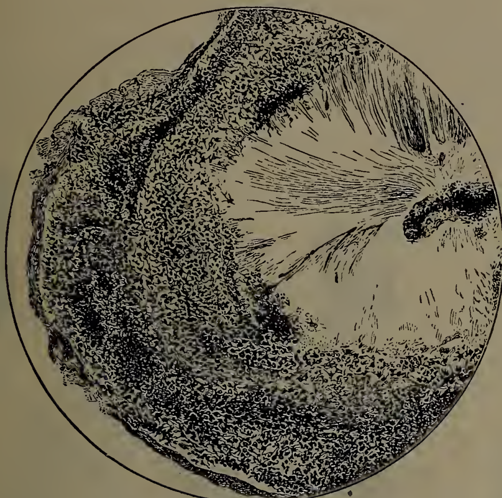


FIG. 612.—From a specimen in the possession of Douglas Caush.

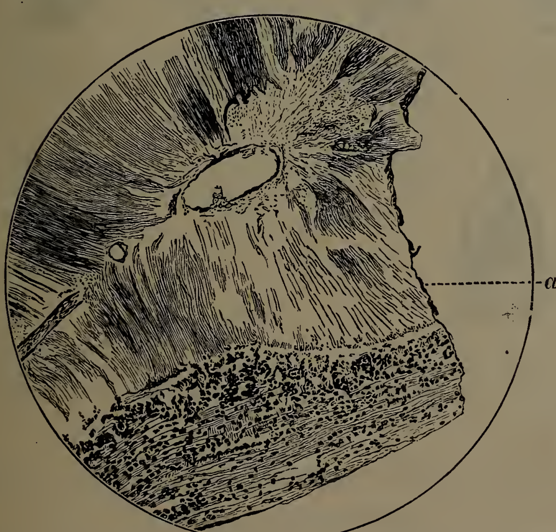


FIG. 613.—(*a*) Margin of tooth, showing Howship's lacunæ. From a specimen in the possession of Douglas Caush.

tooth shows a series of semilunar excavations (Howship's lacunæ) (fig. 613).

In each space a multi-nucleated cell is present, and in the neighbourhood are to be seen epitheliod cells and small cells, the appearances being in all respects similar to those seen in absorption of the deciduous teeth under normal conditions. As the absorption progresses, the cementum is first removed and then the dentine, and, in rare cases, the entire root may disappear. The absorption of the teeth may take place evenly as seen in figs. 614 and 615, or in an irregular manner as seen in figs. 616 and 617. The difference

Fig. 614.

Fig. 615.

Fig. 616.

Fig. 617.

Fig. 618.

Fig. 619.

Fig. 620.

Fig. 621.

Fig. 622.—Maxillary second molar showing absorption of root due to an unerupted third molar.

Fig. 623.—Mandibular second molar showing absorption of root due to an unerupted third molar.

probably depends upon the character of the injury and whether the injury is continuous or intermittent.

Under certain conditions, e.g., the lessening in the intensity of the injury, *the rarefying periodontitis may pass into the stage of proliferative periodontitis* and much of the lost tissue may be replaced, to be, perhaps, again removed if the inflammatory process resumes greater activity. In other cases, the inflammation may

cease altogether and the small-celled infiltration be replaced by cementum. In the case shown in fig. 624 the dentine has been absorbed and replaced by cementum. This specimen therefore indicates the existence of a rarefying periodontitis, followed by the replacement of the small-celled infiltration by cementum, a condition analogous to healing in soft tissue by granulation.

Chronic injury to the periodontal membranes at times results in changes which are more marked in the surrounding osseous tissue than in the tooth itself. The bone in the neighbourhood of the tooth is removed and its place is taken by a mass of granulation tissue, the outer layer of which shows a tendency to fibrosis. These

Fig. 624.—From a specimen in the possession of Douglas Caush.

masses of tissue often come away with the tooth when it is extracted (see also p. 507).

When the injury persists and is of a septic or infective type suppuration ensues and produces a condition commonly known as *chronic suppurative periodontitis*. The injury usually reaches the membrane through the apical foramen. It is doubtful whether the microbes can pass through the tooth structure. There is, however, no reason to doubt that *toxins* generated in the pulp canal may *easily* diffuse through the tooth tissue and injure the periodontal membrane. The pus formed from the degeneration of the tissues may become more or less confined through being surrounded by a layer of granulation tissue, the outskirts of which show a tendency

to fibrosis, and the abscess thus formed may remain stationary and give rise to no symptoms. More often, however, there is a tendency for the suppurative process to extend slowly, generally in the direction of least resistance, with the result that the alveolar process is destroyed, an opening appears on the gum, and a sinus is formed.

In discussing acute suppuration it was explained at what positions the abscess might be expected to point (see p. 472). The same positions may also be regarded as the probable sites of the pointing of chronic abscesses.

The extent of destruction of the bone which may occur in chronic suppurative periodontitis is shown in the specimens to be now described.

The mandible of a child about six years of age is shown in fig. 625.

Fig. 625.—Mandible showing destruction of bone around the roots of the deciduous molars.

The bone around the apices of the anterior roots has been destroyed sufficiently to form definite cavities; the outer aspects of the roots throughout their entire length have been denuded of bone. The destruction of bone is more marked in connection with the second than the first molar. The skiagram of the specimen, fig. 626, should be contrasted with that in fig. 627, which is taken from a normal specimen.

If the fleshy covering of this specimen (fig. 625) could be reinstated we should see a marked marginal gingivitis; teeth covered with food débris; sinuses opening into the sulcus between the gum and the cheek and constantly discharging pus. The child would be typical of many seen at the present time.

A less severe condition is seen in fig. 628. The right second mandibular molar has been attacked by caries, the destruction of

the dentine having at the time of death just reached the pulp cavity. The bone intervening between this tooth and the first deciduous molar has been destroyed and the upper two-thirds of the anterior root has been denuded of its bony cover. There is no appearance

Fig. 626.

Fig. 627.

of trouble around the apex of the root. The skiagram (fig. 629) of this specimen shows the extent of the bone destruction. It will be noticed that the crypt of the first premolar has been opened on

Fig. 628.—Skull and mandible of a child about six years of age, showing the effects on the bone of suppuration in connection with the right second mandibular molar.

the distal aspect and that the bony layer which should exist between the second premolar and the second molar has disappeared. Put on the covering of soft tissues and we should probably see food packed between the deciduous molars, with the anterior root of the

second molar partially denuded, and marked sepsis which would be in free communication with the growing premolars.

The maxilla of a child, just over nine years of age, shown in fig. 630, demonstrates that considerable loss of bone may occur. The complete bony covering of the crown of the second premolar

FIG. 629.—Skiagram of the specimen shown in fig. 628.

has been destroyed, and the posterior aspect of the socket of the first premolar has partly disappeared.

The maxillary incisors, owing to their position, are frequently injured by trauma and it is by no means uncommon to see a transverse fracture just below the neck. The root at times is left untreated, with the result that, owing to sepsis, the pulp is destroyed

FIG. 630.—Maxillæ from a child just over nine years of age. The crypt of the left second premolar has been destroyed by suppuration.

and infection of the periodontal membrane follows. The clinical appearances of this type of case are as follows. The tooth or teeth present are dark in colour; the dentine is hollowed out and is deeply stained and there is a distinct thickening of the mucoperiosteum over the roots of the teeth. A sinus may be present

and pressure over the region of the root gives rise to a definite feeling of tenderness.

The morbid anatomy of a case of this type is shown in fig. 631. It is the maxilla of an adult. The left incisors have been fractured —the lateral incisor through the crown near the neck of the tooth

FIG. 631.—Maxillæ showing the effects of suppuration around the roots of the right incisors.

and the central incisor through the root just beyond the neck. The central incisor is little more than a hollow cone, the lateral incisor on the other hand, has undergone little destruction. A well-marked

FIG. 632.—Skiagram of the specimen shown in fig. 631.

cavity is present in the bone, the central incisor only retaining a connection with the bone at the posterior aspect of the root, while the lateral incisor has the distal and posterior aspects of its socket still intact.

The skiagram of this specimen is shown in fig. 632.

The points to be noted are:—

(1) That there is no well-defined line between the cavity and the surrounding bone, such as is noticeable in skiagrams of cysts.

(2) That there is indication of bone posterior to the roots.

The morbid anatomy of palatal abscesses is shown in fig. 633. The pulp of the left central incisor has been exposed by attrition, an abscess has formed around the apex of the root and has then made its way through the outer alveolar plate. The lateral incisor which shows marked attrition has been attacked by caries and the suppuration of the pulp has been followed by infection of the bone. The destruction of the bone has laid bare the whole of the roots

Fig. 633.—Side view of a specimen showing bone destruction in connection with a lateral incisor.

of the incisors and the upper aspect of the mesial surface of the canine root. Extending backwards, the abscess has at one place completely destroyed the bone forming the palatal surface, so that one opening exists near the anterior palatine foramen. In its forward extension the abscess has opened into the cavity previously formed around the central incisor and by this means there is a free communication through the outer alveolar plate. The skiagram of this specimen is seen in fig. 634.

This type of case would present the well-recognized clinical features of a palatal abscess. There would be a swelling in the palate, with a bulging of the tissues over the anterior aspect of the tooth and definite fluctuation between the two surfaces.

A dento-alveolar abscess in connection with the maxillary canine

usually opens through the anterior alveolar plate about the region of the apex of the tooth. More rarely the pus will track towards the nasal fossa and, discharging into that cavity, give rise to a

Fig. 634.—Skiagram of specimen shown in fig. 633.

persistent unilateral nasal discharge. A specimen illustrating this latter condition is shown in fig. 635. Above the right canine there is a large excavation in the bone. The cavity is oval in shape and

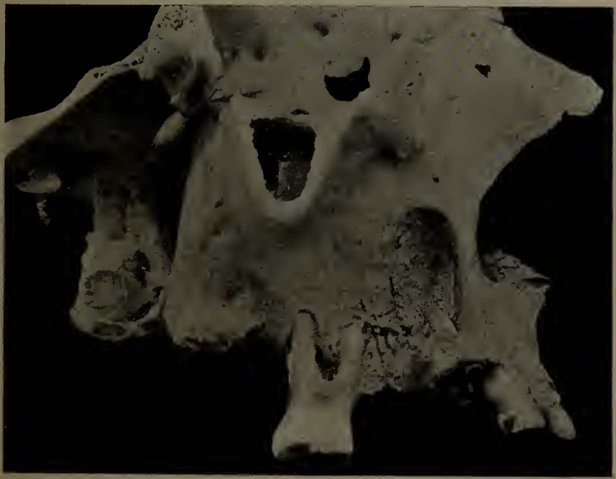


Fig. 635.—Specimen showing bone destruction in connection with the right canine. The abscess has opened into the nasal fossa.

has been formed at the expense of the nasal process, the bone at one place being perforated so as to connect the abscess cavity with the nasal fossa.

The extensive destruction of bone that may occur around the

roots of premolars is shown in figs. 636 and 637. The teeth have been robbed of their bony surroundings except on the lower half of their palatal aspects, the destruction of the bone being especially noticeable in the region of the apices. If the teeth in such a case are alone removed, the healing is considerably delayed: on the other hand, if the bridge of bone holding them is also taken away free drainage is obtained and rapid healing of the wound follows.

Fig. 636.—In this specimen there has been extensive bone destruction in connection with the premolars. View from the buccal aspect.

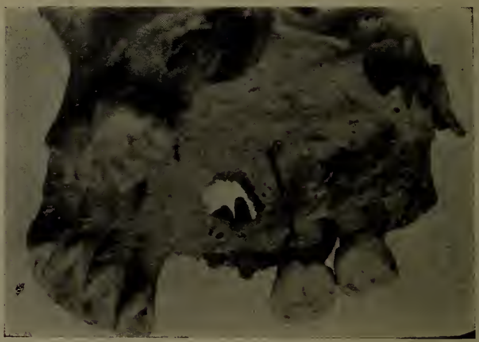


Fig. 637.—Palatal view of the specimen shown in fig. 636.

In the mandible, the extension of the abscess is generally more limited owing to the denser character of the bone, but very extensive excavation of the bone is occasionally seen. With the extension of the suppuration, fresh bone is deposited by the periosteum, and, in this manner, the mandible may become considerably expanded.

The morbid anatomy of a case of chronic suppuration around a partially erupted mandibular third molar is shown in figs. 638 and 639.

An examination of the specimen points to the condition having existed just prior to death, and it is just possible that death was due

Fig. 638.—Mandible showing osteitis in connection with a mandibular molar.

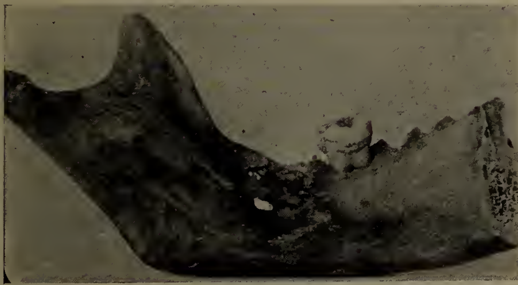
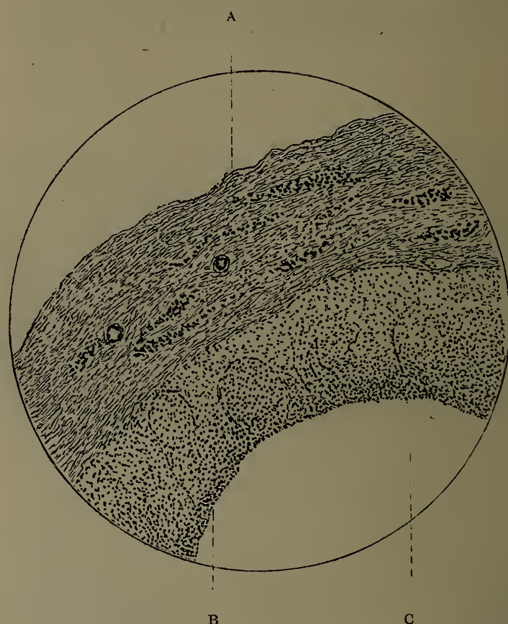


Fig. 639.—View of the internal aspect of the specimen in fig. 638, showing destruction of bone from suppuration around the third molar.

Fig. 640.—Skiagram of the specimen shown in fig. 638.

to septic poisoning from the mouth condition. A view of the inner aspect of the bone shows a deep cavity extending into the body of the bone to a point just below the level of the mandibular canal which has been destroyed leaving the nerve freely exposed. The external aspect of the bone shows a definite deposit of fresh bone which in the centre is pierced by an opening leading to the tooth socket. The skiagram shows clearly the extent of the bone excavation and brings out the relation of the cavity to the mandibular



× 40.

FIG. 641.—Section through the wall of a chronic abscess. (A) fibrous capsule; (B) cells breaking down into pus corpuscles; (C) abscess cavity. From a drawing by A. Hopewell-Smith.

canal. (Reference to excavation of bone by cysts is dealt with on p. 513.)

A section through the walls of a chronic dento-alveolar abscess is shown in fig. 641.

In the process of suppuration, the periodontal membrane may be destroyed, leading to necrosis of the cementum.

There is a somewhat rare form of abscess[1] which occurs in the jaws and which may be described under this heading, as it is in

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[1] *Journ. Brit. Dent. Assoc.*, p. 551, 1899.

reality a sequel to suppurative periodontitis. The abscess may be caused by the presence of a small piece of root in conjunction with insufficient drainage after the extraction of septic teeth. J. G. Turner has drawn attention to this type of abscess. He describes the symptoms as follows: "When the abscess occurs in the maxilla there is pain and tenderness, some swelling of soft parts, but no bony enlargement; the trouble may subside and occur again at intervals. If untreated the antrum may be involved. The nearest lymphatic glands may be enlarged. In the mandible, as in the maxilla, the alveolar process may be entirely absorbed, and there is pain and tenderness and some local swelling. Owing to the position of the inferior dental nerve there is often, especially in the premolar region, severe neuralgia. As in the maxilla, the nearest lymphatic gland may be enlarged and tender. The neuralgia is caused by the abscess in its enlargement opening up the canal of the nerve. Under these conditions there is very severe, continuous, heavy pain, and the more acute shooting pain which occurs at intervals without any necessary regularity; it is set up by any irritation, such as cold air, movement of eating, &c.; it spreads in anatomical order to the other branches of the fifth nerve, first to the ear and then up the side of the ear to the vertex, to the infra-orbital nerve, to the supra-orbital nerve, and down the neck. It lasts a varying time, from a few seconds to hours. It is unaccompanied by trophic changes, but there may be increased secretion of tears or saliva. It is confined to the one side, and appears always to start from the seat of mischief. If the abscess has not involved the inferior dental nerve, the neuralgia will be absent."

"The length of time during which things may lie dormant varies greatly; when, therefore, a patient complains of pain or neuralgia starting in a spot where there is now no tooth, there may yet be a chronic abscess, and the alveolar process may be normally absorbed."

Bacteriology.—The organisms found in dento-alveolar abscesses differ to some extent from the organisms found in abscesses in other parts of the body. Foulerton and Pryce Jones, and later Foulerton, have described a number of members of the streptothrix group which have been found present in the pus of abscesses about the jaw. The forms of streptothrix found did not correspond closely with any of the known varieties of streptothrix. They are found most frequently in those abscesses associated with chronically inflamed roots where the abscess is more in the nature of a sinus than a true abscess. These chronic sinuses in connection with septic roots are often exceedingly persistent. In acute dento-alveolar abscesses one

or other of the ordinary pyogenic cocci is usually present, namely, Streptococcus, Staphylococcus, or Pneumococcus, whilst very occasionally the *Micrococcus tetragenus* may be present. Where the abscess is associated with periodontal disease, the number of organisms present in the pus varies greatly (see p. 561).

In dento-alveolar abscesses in which fœtid pus is present, the fœtid condition is probably not directly produced by the organisms causing the abscess itself, but by changes in the pus arising from the agency of an anaerobic type with which the pus becomes secondarily infected. The *Spirochæte* and the *Bacillus fusiformis* are to be found.

Signs and Symptoms.—Where the injury is slight and leads to a *proliferative periodontitis*, symptoms are often absent and, when present, seldom amount to more than a slight tenderness on percussion and, occasionally, attacks of pain of a dull, gnawing character. *When the inflammatory process is of a rarefying type*, the principal symptom will be slight pain and tenderness on percussion, and, if the inflammation is near the apex and the pulp is alive, there will usually be signs of pulpitis through extension of the disease to the pulp. The gum covering the tooth may be swollen. As the tooth substance disappears, increased looseness will be noticeable, the tooth becoming more tender and the pulp and the gum more congested. In cases of doubt a skiagram should be obtained.

A chronic suppurative periodontitis accompanied by a sinus will exhibit very few symptoms. The tooth is frequently free from pain, the patient only complaining of the presence of the "gum-boil" which periodically swells and bursts. The sinus is usually situated over the root of the tooth. In cases of sinus on the face, some little difficulty may be experienced in tracing the offending tooth, especially if two or three teeth are pulpless or septic. A digital examination of the sulcus will often disclose a fibrous-like cord running from the base of the root to the cheek. The root or tooth causing the trouble may be buried in the gum. A sinus in the mouth in connection with suppurative periodontitis must be diagnosed from sinuses connected with necrosed bone or foreign bodies. In cases of doubt, a skiagram will prove useful. When the sinus is on the face it will be needful to diagnose not only from cases due to necrosed bone or foreign bodies, but also from salivary fistula.

When a sinus is not present (*chronic dento-alveolar abscess*) the tooth is usually slightly tender to percussion, the amount of pain varying according to the activity of the inflammation. The gum

over the root of the tooth is at times swollen and congested, but may be quite normal. A swelling can, as a rule, be felt well up over the apex of the tooth; this swelling is usually sensitive. In cases in which the maxilla or mandible are much involved, there is often little or no pain or tenderness. A chronic dento-alveolar abscess must be diagnosed from dental cysts and other fluid swellings of the jaws (see chapter XXXIII).

Treatment.—The treatment of chronic periodontitis must depend upon the cause. Where the pulp is living and the condition is traceable to overstrain of mastication, relief can be obtained by "freeing the bite," and applying counter-irritants to the gum.

When the chronic periodontitis is traceable to infection from the pulp canal the first question which demands attention is whether the retention of the tooth is advisable. A skiagram should be obtained and, if it is found that there are no signs of rarefying osteitis an endeavour may be made to save the tooth by sterilizing the tooth tissue through the pulp canal; if this is not feasible the tooth should be removed. In the case of septic teeth associated with rarefying osteitis, thorough sterilization of the canals will often be followed by the closing of a sinus, if it exists, and the subsidence of symptoms. Such teeth, although apparently cured, frequently remain a source of infection which may easily be overlooked, and extraction of the tooth is the safer line of treatment. Knowledge acquired in recent years has emphasized the dangers of dental sepsis, and as a consequence our views as to treatment have been modified in the direction of removing septic teeth which we should formerly have endeavoured to retain. Sinuses in the mouth connected with septic teeth usually heal rapidly when the teeth are removed. Sinuses on the face or on the neck are sometimes slow in healing, and it may be necessary to stimulate the track with 10 per cent. solution of nitrate of silver, or a drug possessing a similar action. If this treatment fails, an anæsthetic should be given and the surface of the track scraped. Where a cavity exists in the bone over the tooth, the sinus should be opened up and the cavity scraped and packed to assist healing. Difficulty is sometimes experienced in the healing of palatal abscesses and when this is the case a free excision of the muco-periosteum which covers them will often prove to be a satisfactory procedure.

A depressed scar on the face may result from the healing of a sinus. To lessen the deformity, the attachment of the scar to the bone should be freed and a plate inserted until a sulcus is established. Should further treatment be desirable, the scar should be excised and the edges of the wound sutured with horsehair ligatures.

Streptothrix Infection.—Streptothrix infection in connection with the lesions of the teeth may be conveniently dealt with under "Chronic Local Periodontitis," inasmuch as the infection often takes place via the periodontal membrane.

Streptothrix infection in connection with lesions of the teeth may involve the bone itself or the soft parts, the latter condition being more usually met with.

Clinical Features.—When the soft parts are involved a swelling appears, and gradually increases in size. At first the swelling has a regular and even surface, with the skin slightly hyperæmic. With the progress of the disease, the tissue at places softens and nodular excrescences appear of a yellowish colour; these burst, giving exit to a semi-glutinous fluid in which the characteristic nodules of actinomycosis can be seen. The nodules vary in colour, being yellowish, yellowish-white, or quite clear. The wound generally heals and is followed by a fresh breaking out at another spot. The cicatrization following the repetition of this phenomenon gives the surface a curious puckered appearance which is characteristic of this disease. If left untreated the disease spreads to the tissues of the neck, and in some cases passes upwards to the temporal region. The sinuses formed by the breaking down of the tissue may persist and a probe passed down them will often show that they lead to bare bone, but not necrosed bone. The swelling is of a hard, brawny nature, and fades away gradually into the unaffected tissue. The disease is not accompanied by a rise in temperature, and there is usually no pain. Should acute suppuration supervene, the general symptoms of an ordinary septic abscess appear.

The clinical features of streptothrix infection of the bone simulate necrosis. In the majority of cases there is a history of an acute onset of symptoms; the gums become swollen and bleed readily; the teeth loosen; and there is considerable swelling of the tissues covering the body of the bone. With the progress of the disease the infection spreads along the medullary cavity, clinically expressed by a well-defined edge to the swelling. Eventually the teeth are lost and portions of the bone exfoliate.

Skiagrams show the characteristic appearance as seen in fig. 642. An idea of the morbid anatomy of the condition can be gleaned from the mandible of a wild boar affected with streptothrix infection shown in fig. 643.

Diagnosis.—Streptothrix infection can be differentiated from dento-alveolar abscess by the hard, brawny character of the swelling; the long duration of the disease compared with that of a dento-alveolar abscess, and by the presence of the multiple sinuses or the

puckered cicatrix, the latter being almost pathognomonic. From tubercle it may be differentiated by the fact that in tubercle the glands are usually affected, and the swelling is generally well-defined

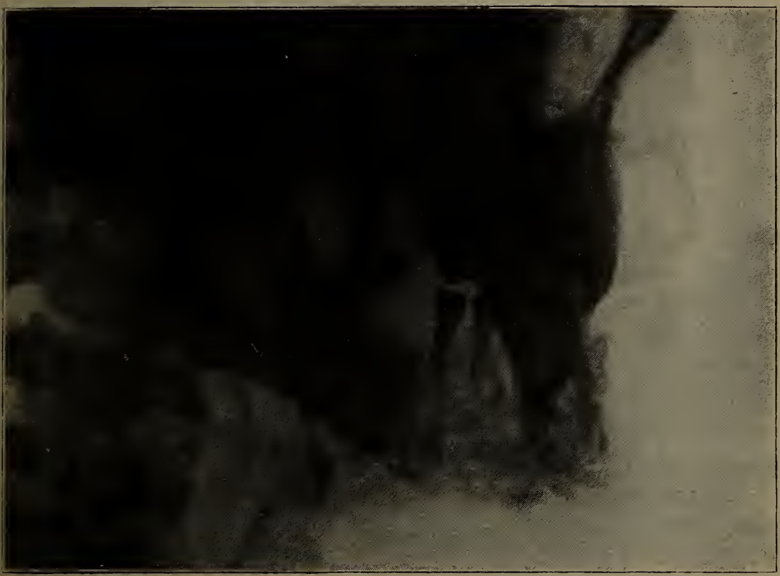

FIG. 642.

FIG. 643.

and movable. From necrosis of the jaw it may be diagnosed by the presence of bare and not necrosed bone. The presence of

granules in the discharge and the demonstration of the streptothrix on microscopical examination are positive evidence.

Pathology.—The disease is due to the presence of a form of streptothrix in the tissues, but the ray fungus of Bollinger (*Streptothrix bovis communis*) is an uncommon cause of human infection. The lesion produced by the growth of the streptothrix is of a chronic inflammatory character. A section through the affected tissue shows a number of rounded areas, in the centre of which is the streptothrix surrounded by a zone of granulation tissue. The tissue breaks down, and the streptothrix is expelled in the discharge. The importance of *streptothricæ* in relation to disease is being constantly extended, and A. G. Foulerton[1] has identified several species in man.

Method of Infection.—The infection is generally stated to be conveyed by straw, cereals, &c. The parasite probably gains an entrance to the tissue via the periodontal membrane, and thence spreads to the neighbouring soft tissue. In specimens of actinomycosis in oxen the invasion of the tissue via the periodontal membrane is often well demonstrated.

Treatment.—Locally the softened spots must be incised and freely scraped and the sinus packed with iodoform gauze. Internally, iodide of potassium must be administered in doses increasing up to 50 or 60 gr. three times a day. It is also useful to add 3 to 4 minims of liquor arsenicalis, as this is considered by Kellock[2] to have some effect on the disease itself, in addition to assisting in preventing the skin lesions.

When the bone is involved the teeth implicated in the affected area must be removed and free drainage established, combined with the administration of potassium iodide. Recovery is usually slow.

The prognosis is good, but the treatment may have to be carried out continuously for a long period.

(ii) Chronic Local Periodontitis commencing at the Gingival Margin

When commencing at the gingival margin, chronic local periodontitis is always due to trauma, such as the injudicious use of ligatures, elastic bands or mechanical contrivances in regulating teeth; the too rapid separation of teeth for filling; collection of food débris in the approximal space.

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1 *Lancet,* March 5, 1910, p. 626.

2 "Actinomycosis of the Mouth and Face," *Trans. Odonto. Soc.,* vol. xxxvii, p. 29, 1904.

Morbid Anatomy and Pathology.—The whole of the periodontal membrane of the tooth may be attacked. This occurs when the irritant is a retained ligature or an elastic band. The gum around the tooth is swollen, congested and painful and the inflammation spreads to the periodontal membrane. By a process of ulceration, the membrane is gradually destroyed, the root laid bare, and in time the apical vessels are involved, leading to pulp complications. The disease may be partial, i.e., the periodontal membrane on one side of the tooth only may be attacked. This condition is seen in the mandibular incisors on the labial aspects, where, owing to deposits of calculus, the membrane is occasionally destroyed to the apex of the root. The most important form from a clinical point of view is that met with in the region of the premolars and molars.

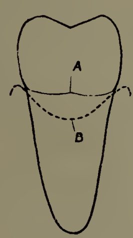

Fig. 644.—(a) neck of tooth and normal attachment of gum; (b) margin of gum.

Fig. 645.

A space may exist between the posterior teeth, and food, especially meat, become wedged between the teeth during mastication. The pressure thus exerted starts chronic periodontal inflammation which, in time, leads to the destruction of the tissue, and the condition, if not treated, will gradually involve the membrane up to the apex of the root. In other cases, the teeth may approximate at the occluding surfaces, but, owing to a slight recession of the gum, food works its way between the approximal spaces during mastication. Unless great care is taken in removing these particles of food a progressive ulceration of the periodontal membrane is started. The membrane is destroyed in a cup-shaped manner, as seen in the diagram (fig. 644), forming pockets, the gum apparently filling up the approximal spaces (fig. 645).

The destruction of the membrane proceeds until the apical vessels are involved and pathological processes are then started in the pulp.

In practice a curious condition is met with in which the internal aspect of the palatine root of a maxillary molar is denuded of its socket. An examination of the root will frequently demonstrate a mass of calculus around the apex of the offending root in addition to a well-marked space between the tooth and its neighbour. The pathology of this condition is not clear. An early stage is shown in fig. 646. In this specimen the jaw is well developed, the teeth

FIG. 646.—A specimen showing destruction of bone around the palatine root of the right first molar.

are free from caries and are arranged in a good arch; there is a slight general destruction of the alveolar process; a deposit of dark calculus around the necks of the teeth on the palatine aspect and a fair deposit of lighter coloured calculus on the buccal aspects of all the teeth. In the region between the right second premolar and the first molar there is a cavity in the bone; the tissue that has disappeared comprises the septum between the teeth and the anterior and internal aspects of the socket of the palatine root. On the apical portion of this root there is an irregular deposit of hard

dark calculus. The surface of the cavity is regular and smooth, suggesting that the cavity is the result of a slow, but constant, excavation.

A more advanced condition is illustrated in fig. 647. Here the process of excavation has extended so as to expose almost the entire palatine root. The edge of the cavity is smooth and regular, sug-

Fig. 647.—A specimen showing extensive destruction of bone around the palatine root of a left maxillary first molar.

Fig. 648.

gesting, as in the previous specimen, that it has been due to slow, but constant, action.

In both the specimens the destruction of bone appears to have commenced in the interval between the second premolar and the first molar, a fact which suggests that the cause may be a piece of retained deciduous tooth which in turn forms a stagnation area, the infection gradually involving the adjacent teeth.

Inflammatory processes around the neck of the tooth occasionally cause rapid destruction of the tooth tissue and the formation of definite cavities. The teeth shown in fig. 648 were removed from a young man who had been injured in an aeroplane. The canine and first premolar had been driven into the bone and only the occluding surfaces of the teeth were showing. They had been in this position for nearly six weeks. On the palatine aspect of the premolar there was a cavity which had spread slightly upwards under the enamel, and examination with a magnifying glass showed that it was due to absorption of the tissues. The canine showed on the distal aspect toward the labial surface a similar but smaller cavity.

A case in which the absorption was extensive is shown in fig. 649.[1] Here, in a mandibular canine, the tooth tissue with the

Fig. 649.

exception of that around the pulp canal had been lost by the process of absorption. There is no doubt that some of the cavities around the cervical region are produced in this way and are not the result of caries. The pathology of the condition is not clear, but it is reasonable to think that it is due to inflammatory reaction in the periodontal membrane.

Signs and Symptoms.—Slight tenderness during mastication, with pulp pain from thermal changes (owing to exposure of the

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[1] Recorded by Martin Henry.

cementum), are the chief symptoms. *In cases due to ligatures or elastic bands*, the gum shows signs of inflammation and pus can usually be squeezed up round the neck of the tooth. There is pain to thermal changes. *In cases due to pressure from mastication* there is extreme tenderness, the gum is swollen and congested and the tooth tender to pressure.

When a pocket exists and the occluding surfaces are in contact, the tags of gum on the labial and palatal aspects of the approximal space appear slightly congested, but the recession from the space is, in many cases, only slightly marked. The patient complains of slight discomfort from food becoming wedged between the teeth and, if there is pain to thermal changes, an examination with a suitable probe will show a considerable destruction of the periodontal membrane, the root of the tooth being frequently denuded to at least half its length.

When occurring between the maxillary molars there is often a tender area over the region of the malar bone.

The diagnosis presents little difficulty. An inflamed condition of the gum; slight tenderness on percussion and pain on touching the exposed cementum are sufficient evidence. Care must, however, be taken to exclude pulp irritation from other causes.

Treatment.—*In the cases arising from ligatures, elastic bands, calculus, &c.*, the cause must necessarily be removed. The socket is then syringed out with a suitable antiseptic (hydrogen peroxide, 10 vols.) and the ulcerated surface treated with some mild escharotic, such as trichloracetic acid (25 per cent. solution).

In cases due to pressure from mastication, careful contour fillings must be made in the approximal surfaces of the teeth (see p. 380) and the exposed cementum treated with nitrate of silver. When the periodontitis is *traceable to the lodgment of food solely*, and is not due to pressure from mastication, the approximal space should be syringed and the surface of the gum cauterized with nitrate of silver. This drug will serve a double purpose, namely, reduce the sensitiveness of the cementum and at the same time promote the formation of healthy granulations in the approximal space. The application by the patient of tincture of iodine every day for a week will result in the disappearance of the pocket and the formation of a space which can be easily kept free from the débris of food.

(3) General Periodontitis

Acute.—In this condition the morbid process involves several teeth as well as the contiguous periosteum of the bone. A general

inflammation of the whole alveolar periosteum has therefore to be dealt with. The condition may have its origin in the periodontal membrane or in the muco-periosteum. The teeth become loose and sensitive to touch. The muco-periosteum is swollen, deeply congested and painful to pressure. The inflammation may resolve, but suppuration is very likely to occur unless prompt measures are taken to relieve the congestion. If suppuration occurs, the periosteum becomes separated from the bone, with the result that necrosis supervenes. The inflammation occasionally passes into a chronic form.

Causes.—General periodontitis may arise in persons exposed to the fumes of phosphorus (see Necrosis of the Jaws). The prolonged administration of mercury and certain other drugs may be cited as a cause. It may arise from injury in patients who are the subjects of syphilis, gout, or rheumatism, or may follow on one of the exanthematous fevers.

Signs and Symptoms.—The local signs and symptoms are similar to those of the local form, except, of course, that several teeth are involved in the process. Pain of a dull, gnawing character is present, and there will be general symptoms of pyrexia. Suppuration, if it occurs, is usually ushered in by a well-marked rigor, and the local pain becomes of a throbbing character.

Treatment.—*Local.*—The application of fomentations with scarification. The mouth should be kept as aseptic as possible.

The *general* treatment will depend upon the cause. A smart saline purge should be administered in nearly all cases. If due to syphilis, iodide of potassium must be given, while cases of gouty and rheumatic origin call for the general treatment of those affections. If the inflammation shows a tendency to suppurate, free incisions must be made down to the bone, followed by the constant use of fomentations.

Chronic.—There is reason to believe that the periodontal membrane may be affected by toxins circulating in the blood-stream. Cases are occasionally seen in which there is a thickening of the cementum on the teeth with no evidence of infection from the gingival margin. The following case illustrates this condition: A female aged 35 complained of indefinite pains about the head and a general feeling of ill-health. There was a history of nasal trouble. The gums were perfectly normal and there were no signs whatever of infection around the necks of the teeth. On percussion, several of the teeth were tender. Skiagrams showed a definite thickening of the roots of the teeth, more especially the premolars and molars. Several of the teeth were removed with no relief to the general

symptoms. The nasal condition was treated and relieved. Signs of chronic arthritis subsequently developed and further skiagrams showed an increase in the cementum of the remaining teeth. The chronic periodontitis would here seem to be due to a cause acting through the blood-stream.

(B) REGRESSIVE CHANGES

The periodontal membrane of elderly persons is at times subject to regressive changes of a fibroid character,[1] which may also occur in persons of less mature years. The normal elements of the parts

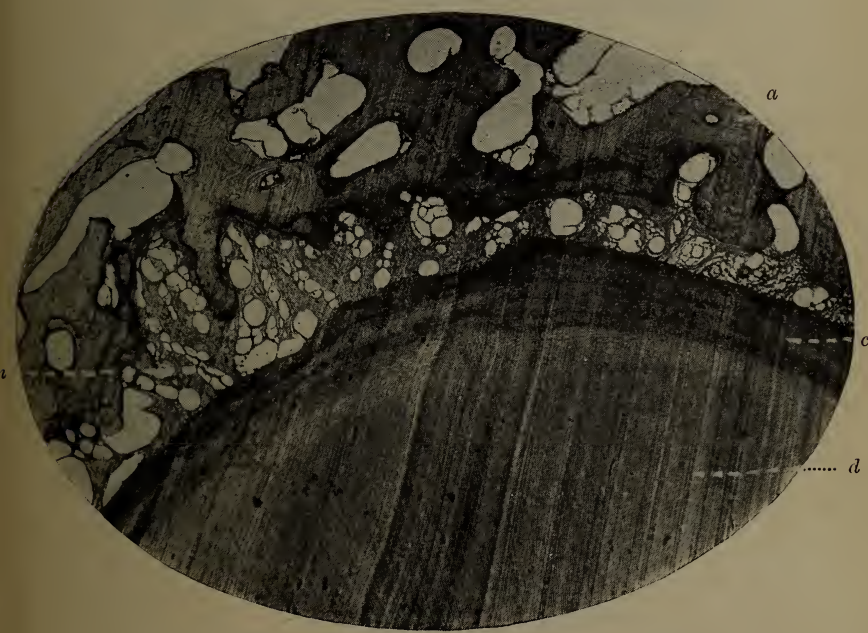

Fig. 650.[2]—(Hopewell-Smith). Transverse section of fibroid degeneration of the periodontal membrane, *in situ*. × 50. (*d*) dentine; (*c*) cementum; (*a*) alveolar bone; (*m*) fibroid periodontal membrane, devoid of cellular elements and vascular and nervous systems.

are replaced by fibrous tissue which is grouped together in bundles enclosing areolar spaces (figs. 650 and 651). The adjacent bone shows signs of atrophy and the gingival tissue in the immediate neighbourhood also shares in the changes by becoming less vascular and more fibroid in character.

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[1] See paper by A. Hopewell-Smith, *Dental Cosmos*, vol. xlvi, p. 261.

[2] From *Dental Cosmos*.

(C) NECROSIS OF TEETH

A tooth derives its nutritional supply from two sources, namely, the pulp and the periosteum. When the death of the pulp alone occurs, a *partial necrosis of the dentine* takes place. From a clinical point of view, this is unimportant and does not give rise to any symptoms if the canal is properly treated. When, in addition to death of the pulp, the periodontal membrane becomes separated from the cementum, partial or complete necrosis of the tooth takes place. *Partial necrosis of the cementum* is common and is generally

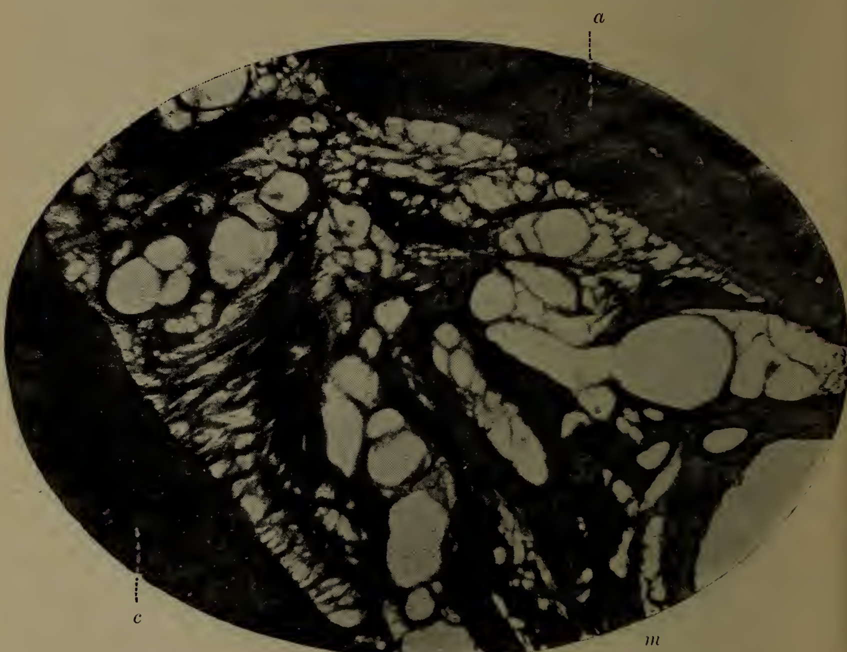


Fig. 651.[1]—(Hopewell-Smith). Transverse section of fibroid degeneration of the periodontal membrane, cut *in situ*. × 260. (*c*) cementum; (*a*) alveolar bone; (*m*) fibroid periodontal membrane showing absence of cells, blood-vessels, nerve fibres, &c.

the result of suppurative periodontitis. Where there is *complete necrosis of the cementum*, the tooth acts as a foreign body.

(D) GRANULOMES

This is a convenient term to describe those masses of tissue often seen in connection with teeth which have been the seat of chronic

[1] From *Dental Cosmos*.

periodontitis. Examples are shown in fig. 652. In some cases the mass is composed entirely of granulation tissue (fig. 653) while in

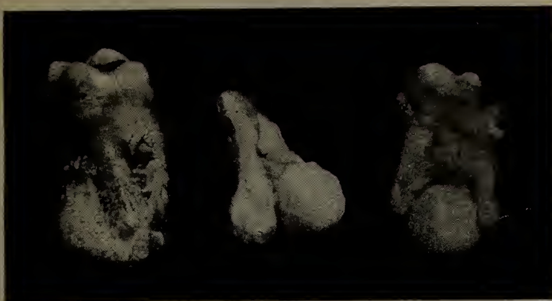
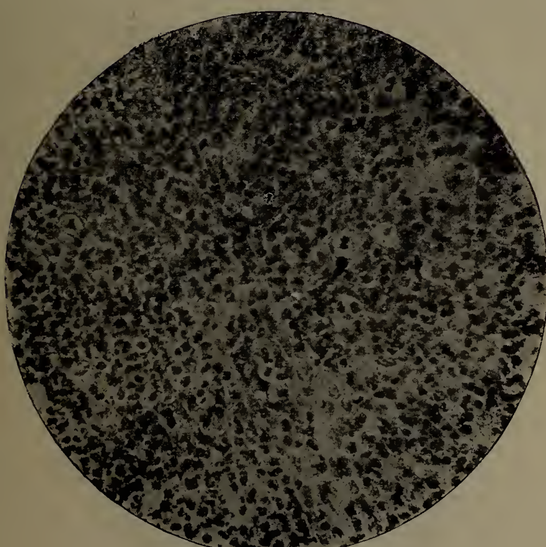


Fig. 652.



× 230.

Fig. 653.[1]—A granulome of the periodontal membrane.

others, in addition to the granulation tissue, epithelial cells or endothelial cells may be present. Figs. 654 and 655 show the general structures of granulomes.[2] In a few examples there is a peculiar

[1] From "The Histology and Patho-histology of the Teeth," by A. Hopewell-Smith.

[2] See an excellent paper by K. H. Thoma, *Dental Cosmos*, January, 1918. I am indebted to the author and the *Dental Cosmos* for permission to reproduce the figs. 654 and 655.

FIG. 654.—Photomicrograph of a granulome stained with Mallory's phosphotungstic acid-hæmatoxylin method to bring out the fibrous part of the tissue. Note the strong fibrous capsule. The inner part of the granulome shows centres where necrosis has taken place. (Thoma). (From the *Dental Cosmos*.)

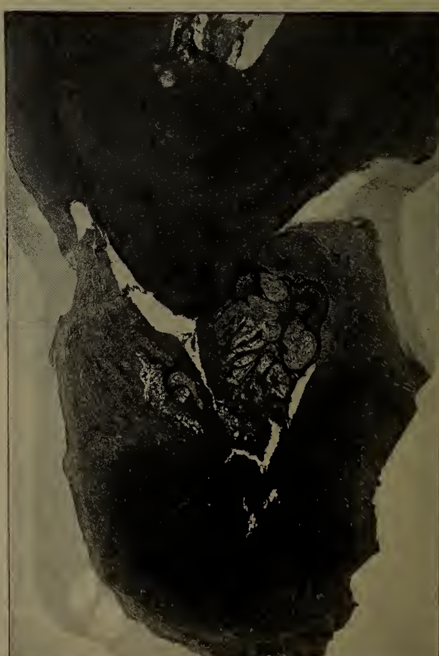


FIG. 655.—Photomicrograph of a dental granulome showing epithelium proliferating in the inflammatory tissue. Note that the epithelial network encloses inflammatory tissue. (Thoma.) (From the *Dental Cosmos*.)

development of mucous tissue.[1] The granulomes containing epithelium vary considerably in structure. In some there is a marked growth of epithelium, whilst, in others, granulation tissue prevails, which would seem to indicate that there is a kind of struggle for existence between the epithelial and the granulation tissue. The epithelium is not always easy to demonstrate. In the two specimens described by Romer the granulation tissue had worked its way into the root canals, and only in that situation was he able to demonstrate epithelial remnants. The epithelial remnants found in these granulomes are probably derived from the "epithelial sheath of Hertwig," which is credited with determining the formation and shape of the dentine of the root. On the formation of the dentine, the surrounding mesoblastic cells invade and partly destroy the sheath, and, applying themselves to the surface of the dentine, form the cementum and alveolar dental ligament (periodontal membrane). Portions of the sheath remain at times undestroyed and these form the periodontal epithelial remnants.

The epithelial granulome is the first stage in the development of a dental cyst.

It is quite possible that some of the varieties of sarcoma met with in the jaws have their origin in the root membrane. In a case recorded by Oakley Coles[2] of a mandibular second molar which had been the seat of chronic periodontitis, the structure of the small growth removed with the teeth was identical in character with a round-celled sarcoma. Hopewell-Smith[3] has also described cases of a similar nature.

(E) ANCHYLOSIS OF THE TEETH TO THE JAWS

Anchylosis of the teeth to the jaws may occur, but it is rare. The pathological changes which produce this condition between the teeth and the alveolar process are similar to those occurring in joints in other parts of the body. An interesting case came under the notice of E. Lloyd-Williams. The patient was a man suffering from suppuration, and a maxillary molar and premolar were removed with large masses of bone attached to them. Examination of the specimens showed them to be examples of anchylosis of the teeth

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[1] See paper "On Granulomes and Tooth-root Cysts." Translated from the *Correspondenz-Blatt für Zahnärzte* (Ash's *Quarterly Circular*).

[2] *Trans. Odonto. Soc.*, vol. xi, p. 115, "On a Tumour Arising from the Root Membrane."

[3] "On Malignant Diseases of the Periodontal Membrane," *Journ. Brit. Dent. Assoc.*, vol. xvi, p. 578.

to the bone. The molar is shown in fig. 656, while a decalcified section of the premolar is seen in fig. 657. It will be noticed that the tooth and bone are intimately connected. An interesting case

Fig. 656.[1]

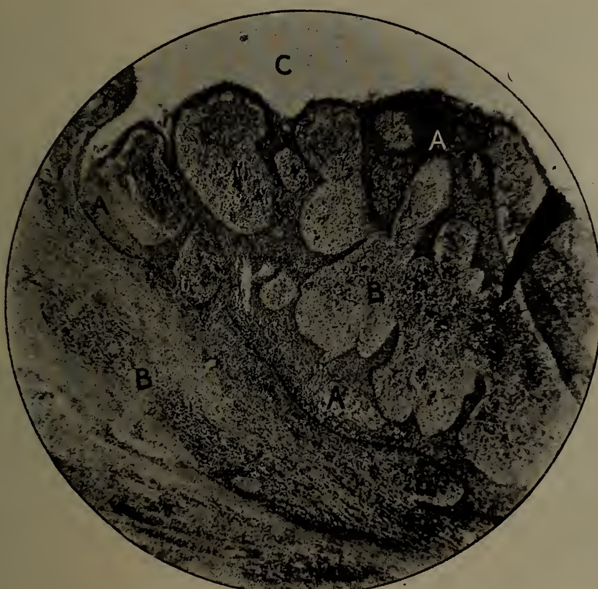
Fig. 657.[1]

[1] Copied from *Trans. Odonto. Soc.*

of anchylosis to the jaw of a retained deciduous molar in a man, aged 40, is described by O. Amoedo.[1]

(F) CYSTS—DENTAL CYSTS

The cysts connected with fully developed and erupted teeth are termed dental cysts. These cysts have their origin from the epithelial masses met with in the periodontal membrane, and are usually caused by toxins from a septic tooth. In a few cases the cause is obscure (see p. 514). The credit for the earliest description of the



× 30, 1½ in. obj., N.A. 0 15.

Fig. 658.[2]—Section of part of an epithelial granulome; c is placed in central cleft. a, trabeculæ of epithelial reticulum, central cells degenerating; b, mesoblastic tissue. (Turner.)

nature of these cysts belongs to J. G. Turner. Dental cysts mostly occur in connection with the molar teeth, and are more commonly met with in the maxilla than in the mandible.

Morbid Anatomy and Pathology.—The formation of a dental cyst probably takes place as follows: The epithelium composing one or more of the aberrant masses proliferates and this eventually leads to the formation of a solid tumour, "epithelial granulome,"

[1] *Journ. Brit. Dent. Assoc.*, vol. xvi, p. 249.

[2] For the figs. 658, 659, 672, 673, 674 I am indebted to Mr. J. G. Turner.

the epithelial portion of which is sometimes in the form of a solid mass, but usually is found as a reticulum or sponge-work (fig. 658). The cells on the periphery of the mass are in a state of active growth, while those towards the centre are in a process of degeneration. Around this epithelial mass a capsule is developed from the surrounding mesoblastic cells. The cells towards the centre of the mass in time degenerate and liquefy, forming a distinct cyst (see fig. 659). The cells at the periphery

× 9¼, 3 in. obj., N.A. 0·1.

FIG. 659.—Section of a small cyst attached to the apex of a root. A, epithelial lining; B, mass of epithelium; C, remains of epithelial reticulum; D, semi-solid contents. (Turner.)

continue to multiply and increase in size, shedding themselves towards the centre and at the same time undergoing a liquefying degeneration. In this way the fluid contents of the cyst are formed, and, by growth at the periphery and degeneration at the centre, the enlargement of the cyst is explained.

Being a fluid growth, the cyst will displace the tissues and enlarge in the direction of least resistance.

Maxilla.—A cyst in connection with the incisor teeth in the early stages forms a cavity at the expense of the cancellous tissues. In growing, the cyst distends its bony walls and pushes its way (*a*) upwards towards the nasal fossa, (*b*) outwards through the

external alveolar plate, (*c*) downwards and backwards through the palate. The morbid anatomy is shown in figs. 660 and 661.

The cyst has destroyed the bone of the outer alveolar plate in one place; penetrated slightly towards the nasal process; extended

FIG. 660.

FIG. 661.

towards the mid-line and laid bare the entire root of the lateral incisor and the upper third of the central incisor; pushed the palate downwards and in one place perforated the bone (fig. 661). A careful

examination of this specimen does not suggest that the pulps of the incisors had died; and further, the alveolar process shows no signs of rarefying osteitis, but the incisors do show signs of excessive attrition in comparison with the remaining teeth.

Fig. 662.

The skiagram, fig. 662, shows the presence of two small cysts in connection with the lateral and central incisors. A sinus led to the cyst in connection with the central incisor, the gum margin was

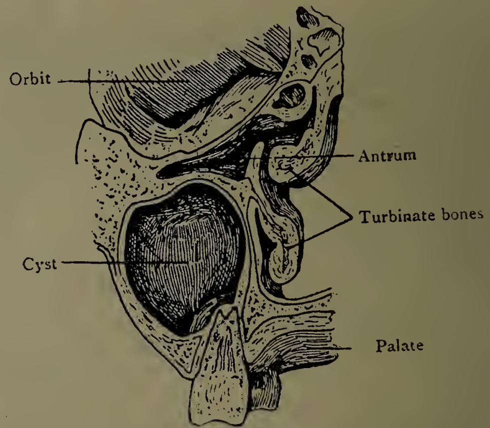


Fig. 663.[1]—Dental cyst pushing up the antrum until it is a mere slit beneath orbit. Modified from Zuckerkandl.

healthy and intact, and the pulps of the teeth were healthy. The teeth had been regulated, and it is possible that the periodontal membrane had been injured by this operation and that the injury had stimulated the development of the cysts.

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[1] From *Journ. Brit. Dent. Assoc.*

In the region of the molars a cyst usually causes bulging of the outer alveolar plate, but the principal extension is towards the maxillary sinus, the floor of this cavity being pushed upwards until, in some cases, the cavity is entirely obliterated (see fig. 663).

The morbid anatomy of a moderate-sized dental cyst in connection with a molar is shown in figs. 664 to 666.

Fig. 664.

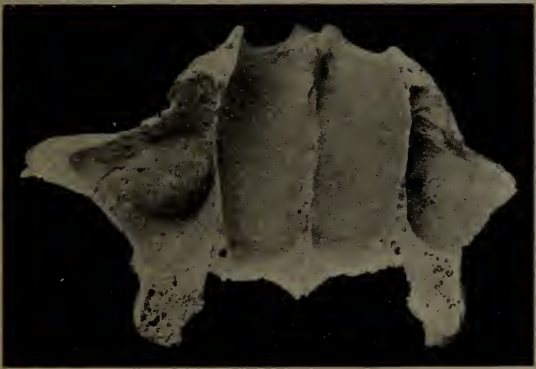


Fig. 665.—Section through the maxillary sinuses of the specimen shown in fig. 664. The cyst has pushed upwards into the sinus.

In the living state this cyst would have formed a globular elastic swelling in the sulcus between the alveolar process and the cheek, the swelling being apparent on the face just under the malar process.

Occasionally suppuration takes place and that part of the cyst wall which bulges towards the maxillary sinus is destroyed and

that cavity becomes infected. The morbid anatomy of this type of case is shown in figs. 667 and 668. The cyst originated in connection with a molar and encroached on the maxillary sinus as shown in fig. 668. The horizontal section through the specimen shows the relation of the cyst to the sinus.

Large dental cysts are occasionally seen in the maxilla; in one case the cavity extended from the central incisor to the third molar.

Mandible.—In the mandible a cyst in the first stages destroys the cancellous bone and, as it increases in size, pushes outwards the external alveolar plate (see figs. 669 to 671). A cyst enlarges in length more than in depth and may form a cavity extending from the first premolar to the last molar. Large cysts may cause distension of both external and internal alveolar plates. Occasionally cysts involve the inner plate only.

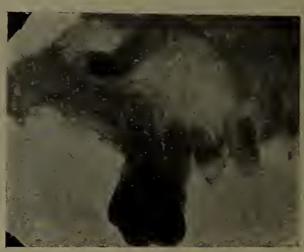


FIG. 666.—Skiagram of the specimen shown in fig. 664.

If a cyst in its growth comes into contact with the roots of teeth, it does not bare them of their living surroundings. Further, the root from which the growth originates never projects bare into the cavity of the cyst.

Contents.—A dental cyst contains a viscid, translucent, mucus-like fluid, with also crystals of cholesterin in suspension. *Chemical examination* shows the presence of proteids in the form of serum albumin and serum globulin, the latter being more abundant. There is an abundance of cholesterin, but no fats or fatty acids. A small quantity of nucleo-albumin is also present.

Structure of the Cyst Wall.—A section through the wall of a dental cyst shows an outer layer of connective tissue which forms the capsule. The capsule is lined with epithelium which may be of the stratified variety or the cells may tend to assume a stellate form similar in appearance to those of the body of the enamel organ. The cells which immediately border the cavity are in a state of degeneration (not colloid). Occasionally, columnar ciliated epithelium is met with (see figs. 672 to 674).

Fig. 667.—a, opening through the outer wall of the maxillary sinus to show the bony wall of the cyst.

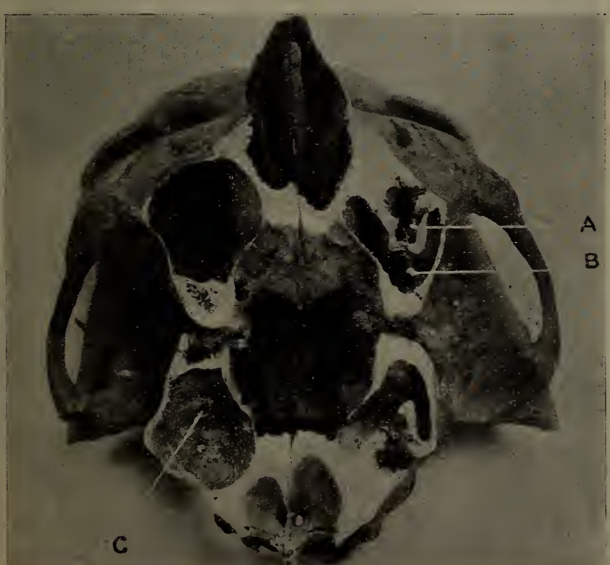


Fig. 668.—a, cyst; b, maxillary sinus; c, sinus opening through the floor of the maxillary antrum.

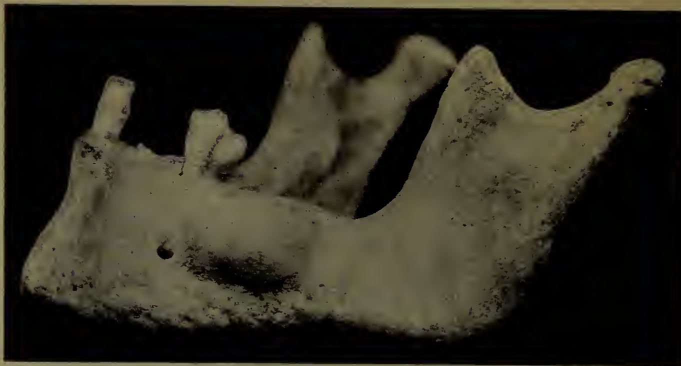
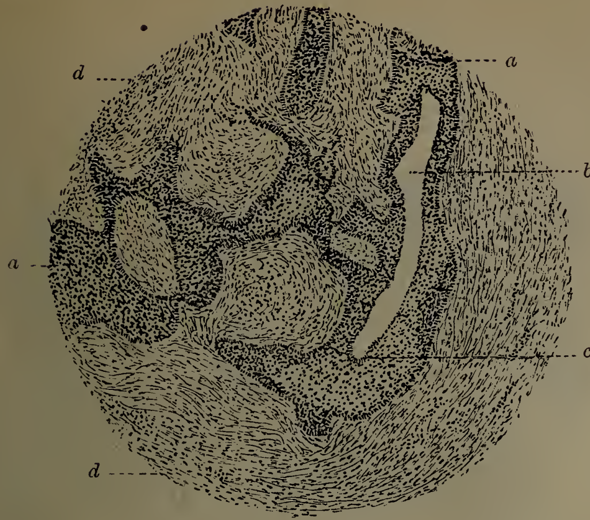


FIG. 669.

FIG. 670.

FIG. 671.—Skiagram of the specimen shown in fig. 669.

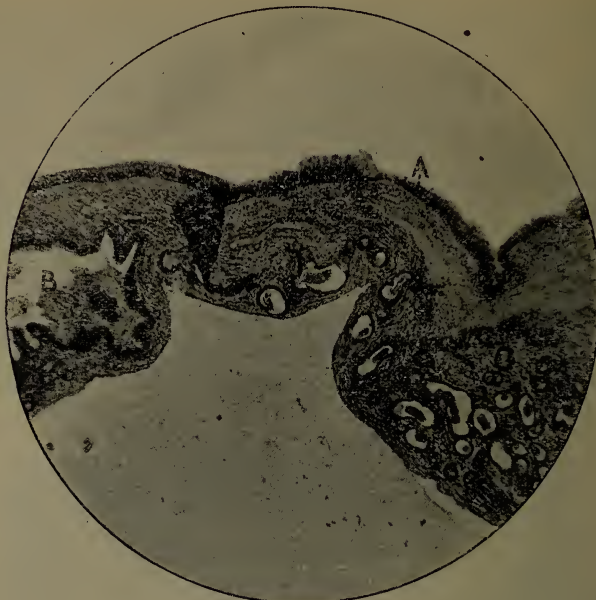


× 40.

FIG. 672.—Dental cyst—early stage of formation (from a drawing by A. Hopewell-Smith). *a,* epithelial cells; *b,* cyst cavity; *c,* a few ciliated columnar epithelial cells; *d,* connective tissue.

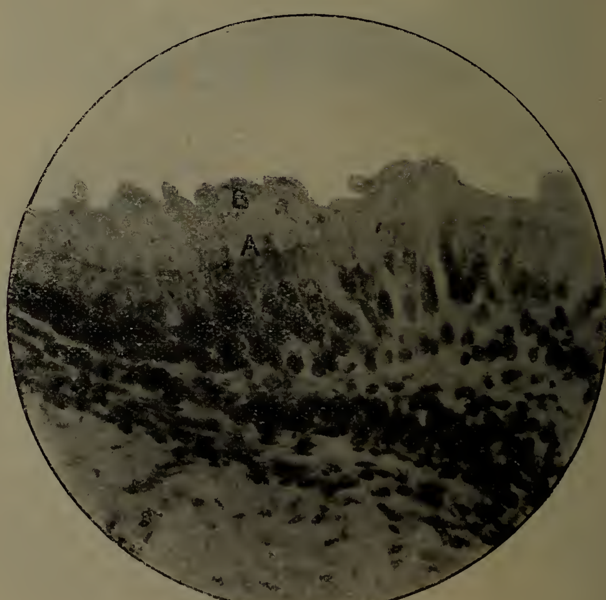
× 110, ½ in. obj., N.A. 0·4.

FIG. 673.—Section of wall of large dental cyst. A, thin regular lining of epithelium; B, connective tissue capsule. (Turner.)



× 43, 1½ in. obj., N.A. 0·15.

FIG. 674.—Section of wall of dental cyst showing columnar ciliated epithelium and loculi. A, columnar ciliated epithelium; B, large irregular acinus; C, smaller acini and tubules. (Turner.)



× 350, ⅙ in. obj., N.A. 0·6.

FIG. 675.—Section of dental cyst showing at A, ciliated epithelium; B, products of degeneration or secretion. (Turner.)

The epithelial cell growth may be very active, and the connective tissue wall may be very thick and approach in structure a multilocular cystic tumour in which one loculus has far exceeded the others in growth. In some cysts micro-organisms can be demonstrated in the contents and also in the inner periphery of the wall.

The walls of dental cysts occasionally show an angiomatous structure (fig. 676).

Signs and Symptoms.—Dental cysts give rise to smooth, globular swellings. The growth is slow but progressive. Inflammatory symptoms are usually absent, the mucous membrane being

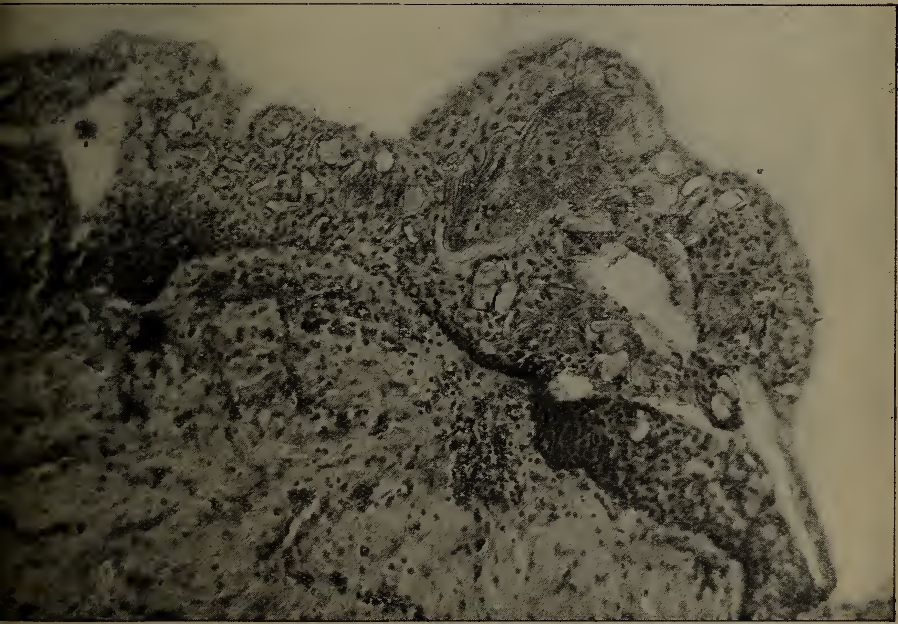


FIG. 676 —Wall of a dental cyst angiomatous in structure, and in a state of marked hyaline degeneration. (*Dental Cosmos*, July, 1918.)

freely movable over the surface of the tumour. Occasionally, dental cysts suppurate, and the symptoms of pus formation will then be added to the physical signs of tumour growth. Pressure on the surface of the swelling will frequently produce a peculiar sensation of crackling, demonstrating the presence of a thin layer of bone. When a cyst penetrates through the bone distinct fluctuation can be obtained, the fluctuating area being frequently bounded by a bony edge. *The differential diagnosis* from other swellings in the jaw is dealt with in chapter XXXIII.

Treatment.—The septic roots must be removed. The cyst should then be exposed by removing a considerable portion of the outer wall; the contents should be removed, and the walls thoroughly dissected out or scraped away. If any portion of the wall be allowed to remain recurrence may take place. The cavity of the cyst should be packed lightly with an antiseptic gauze for the first twenty-four hours, and after this the cavity may be allowed to drain into the mouth.

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CHAPTER XVIII

Chronic General Periodontitis commencing at the Gingival Margin — Synon.: Periodontal Disease; Pyorrhœa Alveolaris; Alveolar Osteitis; Interstitial Gingivitis.

The Anatomy of the Periodontal Membrane—Morbid Anatomy—Clinical Appearances—Condition of the Teeth—Sequelæ—Pathology—Bacteriology—Etiology—Treatment.

Chronic general periodontitis consists in a progressive destruction of the tooth socket, accompanied sometimes in the earlier and almost always in the later stages by a free discharge of pus from the gum margin. Descriptions of the disease will be found in the works of Ambrose Pare, Fauchard, Toire, John Hunter, and others. These authors, however, only described the disease in its advanced stages, the incipient stages not having been recognized until recent years. This disease is widely distributed throughout the human race, and is also met with in animals under domestication, and wild animals kept in captivity.

Various names have been given to the condition, e.g., Riggs' disease, pyorrhœa alveolaris, alveolar osteitis; &c. The disease, as far as our present knowledge guides us, would seem to start in the gingival tissues, and thence spreads to and gradually involves the whole of the tooth attachments. It is this latter condition which is the characteristic feature of the disease, and it would therefore seem appropriate to describe the lesion as a chronic general periodontitis.

(A) THE ANATOMY OF THE PARTS INVOLVED IN THE DISEASE

Before a description is given of the morbid anatomy of periodontal disease, it is necessary to consider certain aspects of the normal anatomy of the parts involved in the disease in order that the pathological changes may be more readily appreciated.

As regards the mandible, fig. 677 shows that of a female, aged 22.

The alveolar process may be regarded as normal. The alveolar process and the teeth sockets are everywhere lined with a fairly dense layer of bone which appears in the skiagrams, fig. 678, as a dark line. On the buccal aspect in the premolar and molar region the margin of the bone is close below the necks of the teeth, and, stretching across from one tooth to another in a straight line, forms the base of a definite triangular space between the approximal aspects of the teeth. In the incisor region the bone does not follow

FIG. 677.—Mandible of female, aged 22, with an alveolar process which may be regarded as normal.

FIG. 678.—Skiagrams showing the appearance of the bone in the mandible (fig. 677).

a straight line, but is continued upwards, so that the space between the incisors is considerably less than between the premolars and molars. The margin of the bone presents a regular outline, and the surface of the bone, which is smooth, is pierced here and there with nutrient canals. The appearance of the bone in skiagrams is shown in fig. 678. Between the front teeth the bone has the

appearance of a sharp spine, but it passes in a straight line between the back teeth. The outer aspect of the bone shows a dense layer, the inner part presenting a cancellous appearance. In the maxilla a similar condition obtains.[1]

As age advances the alveolar process tends gradually to disappear. In healthy mouths, the gum margin recedes as the alveolar process disappears and a layer of compact tissue is constantly present over the alveolar process. The muco-periosteum should be firm and pale pink in colour. It should blend with the periodontal membrane at the neck of the tooth, the junction being distinguishable by the greater density in the character of the fibrous tissue. This band of tissue has been termed by G. V. Black the *dental ligament*. The gingival margin of the muco-periosteum is not attached to the tooth on the general level of the gum, as the gum falls slightly before reaching the tooth and forms a slight depression around the tooth. This depression is generally termed the "gingival trough." The floor of the depression is at the neck of the tooth, and consequently with the eruption of the tooth the depth of the depression decreases. It is stated by Goodrich and Moseley[2] that leucocytes from the lymph glands make their way through the epithelium, and they maintain that these glands and not the tonsils are the main source of the salivary corpuscles. "The corpuscles which make their way through the epithelium opposed to the tooth collect in the gingival space where Mendel[3] has recently recorded their presence in healthy persons." This would seem to suggest that the leucocytes play the part of phagocytes in freeing the gingival space from organisms.

(B) MORBID ANATOMY

Clinical experience indicates that periodontal disease usually originates in the molar region or around the incisors. When it originates around the back teeth, the initial lesion in the bone is a slight destruction of tissue in the centre of the interproximal spaces as shown in fig. 679, a specimen which has the appearance of being normal unless carefully scrutinized. The disappearance of the layer of dense tissue and the breach into the cancellous bone indicate that the destruction of the bone has already commenced (fig. 680). As the destruction of the bone proceeds the outer and

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[1] The skiagram of the incisors shows a slight break in the compact tissue towards the apex of the spine, but this is due to slight fracture (post mortem)

[2] *Journ. Roy. Micro. Soc.*, 1916, p. 514.

[3] *Comptes rendus Soc. Biol.*, 1916, pp. 587-593.

inner plates of the alveolar process become involved, but the loss of tissue, as a rule, is greater between the teeth than on the buccal and palatal aspects. This stage is shown in fig. 681. It will be observed that:—

(1) The destruction of bone around the front teeth is considerably less than around the premolars and molars.

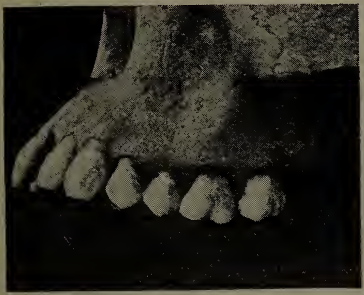

Fig. 679.

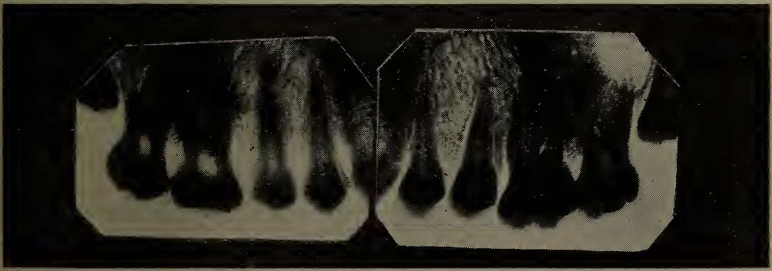

Fig. 680.—Skiagrams of the specimen shown in fig. 679. Note the slight destruction of the bone in the centre of the interproximal spaces.

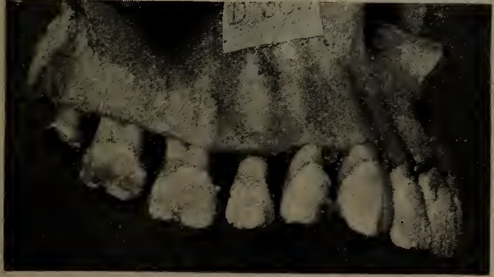

Fig. 681.—Maxilla in which the destruction of the bone has advanced beyond the stage shown in fig. 679.

(2) The loss of tissue around the molars is greater than around the premolars.

A further stage of the disease is shown in fig. 682. The bone has so far disappeared as to expose about half of the roots of the

Fig. 682.—Maxilla showing considerable destruction of the alveolar process.

incisors and two-thirds of the roots of the molars. Around the canine and premolars the bone destruction is less advanced.

A specimen in which the disease probably commenced around the incisor teeth is shown in fig. 683. There is some loss of bone

Fig. 683.—Specimen in which the disease probably commenced around the incisors.

between the teeth, and the roots on the labial aspects are uncovered. The margin of the bone shows the pitted, irregular appearance characteristic of rarefying osteitis. It will be observed that there has been less destruction of bone between the central incisors than between the other front teeth. An examination of

the specimen shows that around the incisors the destruction of bone is more advanced than around the molar teeth. The skiagrams, fig. 684, bring out clearly the extent of the bone lesion and also the resistance of the tissues between the central incisors.

The specimen shown in fig. 685 from a male, aged 30, is an excellent example of the morbid anatomy of an advanced case.

Fig. 684.—Skiagrams of specimen shown in fig. 683. The extent of the bone lesion and the resistance of the tissues between the central incisors is clearly shown.

Fig. 685.—This specimen from a male, aged 30, shows the morbid anatomy of an advanced case of periodontal disease.

The bone around the incisors has almost disappeared, and the molar teeth are uncovered nearly to their apices. Around the teeth are cup-shaped spaces which are due to the fact that the bone bordering the tooth disappears first. The appearance of the bone shows that there has been a marked rarefying osteitis. Nodular deposits of calculus are present on the teeth, and it will be observed that

these are, in the case of the incisors, canines, and premolars, well away from the margin of the bone. The skiagrams of this specimen are shown in fig. 686. The cup-shaped absorption of the socket is

FIG. 686.—Skiagrams of maxillæ shown in fig. 685.

FIG. 687.—Maxilla showing cup-shaped absorption of the bone around the right first molar.

clearly shown in the right first molar of the specimen illustrated in fig. 687. Around the second molar the destruction of the bone

has been of a more chronic type, the cup-shaped absorption being absent. The skiagram of these two teeth (fig. 688) shows a very distinct difference in their appearance. Around the roots of the first molar there is a definite clear area and the dense layer which

FIG. 688.—Skiagram of the first and second molars in fig. 687, showing the different degrees of bone destruction around these teeth.

marks the outline of the normal socket is absent. The bone around the tooth shows definite signs of rarefying osteitis. The bone bordering the roots of the second molar still retains the dense

FIG. 689.—Final stage of the disease. The teeth have fallen out owing to the extensive destruction of the surrounding bone.

appearance, and this indicates that the rarefying process has not spread deeply into the bone around the tooth.

In the final stage of the disease the teeth fall out owing to the extent of bone destruction. The specimen shown in fig. 689 is an excellent example. The premolars and molars have fallen out and

the alveolar process has entirely disappeared. The condition of the mandibular canine shows how the final loss of the tooth is brought about. In the living subject this advanced stage of the disease is denoted by the absence of "ridges."

Fig. 690.—A specimen in which the bone shows marked reaction. Note the thickened margin of the alveolar process.

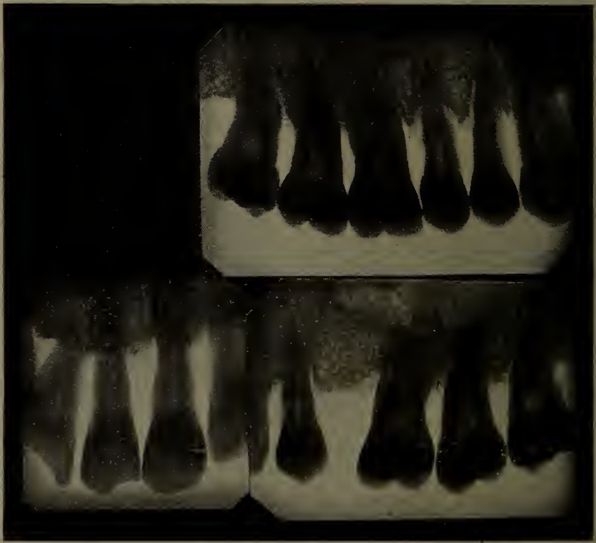

Fig. 691.—These skiagrams of fig. 690 show that the rarefaction of bone is to a great extent limited to the surface.

In specimens showing marked attrition of the teeth the outer aspect of the alveolar process is often thickened and the rarefaction of the bone is limited to the alveolar margins. A case of this type is shown in fig. 690. The skiagrams (fig. 691) show that the rarefying process is almost entirely limited to the surface and has not

spread deeply into the sockets. Compare the skiagraph appearance of the bone around the incisors in this specimen and in the specimen shown in fig. 685. The marked attrition of the teeth indicates that the function of mastication has been efficiently performed, and the bone around the teeth, having therefore been kept well nourished with a plentiful flow of blood, was in a favourable condition to react to injury.

A specimen in which there is greater thickening of the bone is shown in fig. 692. The position of the calculus in relation to the margin of the bone is evidence that well-defined pockets existed around the teeth. The surface of the bone around the teeth shows signs of a rarefying osteitis, but there is no cup-like absorption of

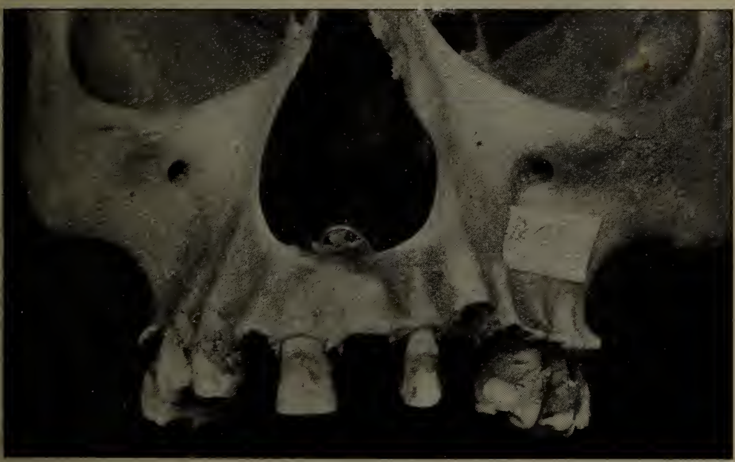

Fig. 692.—A specimen from a very chronic case showing considerable thickening of the margin of the bone.

the bone. The thickened bone beyond the surface indicates a "sclerosing" inflammation. The arch is well formed and the attrition of the teeth on the masticating surface points to good functional activity.

An example of the formation of nodular masses of bone is shown in fig. 693.

In practice a type of case is met with in which the bone destruction on the labial and palatal aspects of the teeth is much more advanced than on the approximal aspect. In many of these cases the gum margin is very little above the neck of the tooth, and a probe inserted between the gum and the tooth will pass almost to the end of the root. This condition is generally associated with

the anterior teeth, and not infrequently with patients whose teeth are unduly prominent. A specimen illustrating the morbid anatomy of this type of case is shown in fig. 694. The bone on the labial

Fig. 693.—A specimen showing the formation of nodular masses on the outside of the alveolar process.

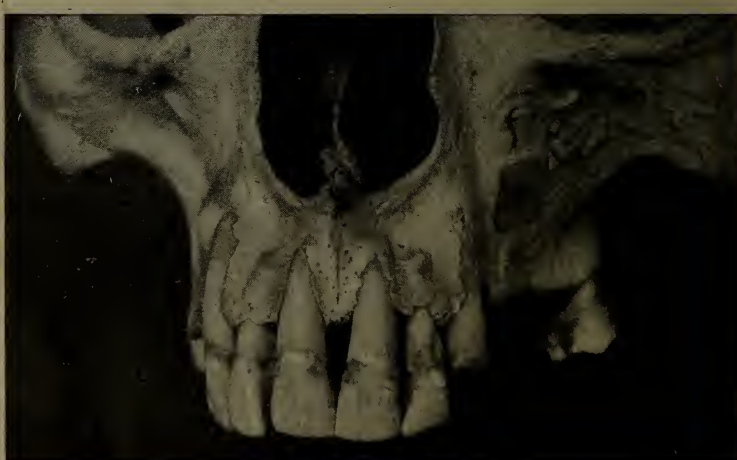

Fig. 694.—In this specimen the bone destruction is most marked on the anterior aspects of the teeth.

aspects of the right canine and central incisor has completely disappeared; the left central incisor and canine are only covered by bone in the neighbourhood of the apices. Note the deposit of calculus

around the necks of the teeth and the freedom from calculus of the remaining exposed portion of the roots. On examining the position of the teeth in relation to the bone, it will be seen that the arch is

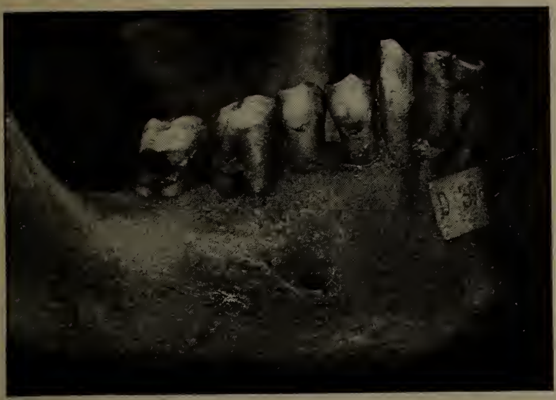

FIG. 695.—Mandible from an advanced case of periodontal disease in the region of the mandibular molars.

FIG. 696.—Skiagrams of the specimen shown in fig. 695.

decidedly narrow and that the general direction of the teeth is too vertical.

A point worthy of attention is that the disease spreads in the

maxilla more actively and extensively than in the mandible; especially is this the case in the region of the molars. The more limited area of bone destruction in the mandible is due to the nature of the osseous tissues, the bone in the maxilla being of a much more cancellous character than in the mandible.

A mandible showing extensive destruction of the bone in the region of the molars is shown in fig. 695, and the skiagrams of the specimen in fig. 696.

The series of specimens just described indicates that the bone lesion is a progressive rarefying osteitis which commences at the margin of the tooth socket and eventually destroys the bone until the tooth is shed owing to the loss of its attachments.

The Teeth

Teeth taken from cases of periodontal disease exhibit definite changes. The hard tissues may show absorption and the periodontal membrane may be thickened—indications of a chronic inflammatory process. When the hard tissues around the apex of a tooth are being absorbed the presence of periodontitis is indicated, and periodontitis necessarily implies pathological changes in the adjacent bony tissue. The degree of rarefying osteitis may be gauged by the rapidity of tooth absorption and the liability to direct infection of the tissues increases in proportion to the amount of rarefying osteitis. The condition of the teeth in fig. 697 indicates that there was marked rarefying osteitis and probably direct absorption of toxins, &c., into the blood-stream. Skiagrams of the alveolar process of the patient are shown in figs. 698 to 700.

Large masses of adventitious tissue are frequently found in the cleft between the roots of the molar teeth, indicating extensive loss of osseous tissue at those points. The condition of the teeth in cases exhibiting deep pockets and profuse suppuration is well shown in the specimen illustrated in fig. 701.

T. B. Hartzell[1] considers that the lymphatic drainage of the tissues contiguous to the teeth is the most perfect in the body, and he states that the very method of attachment of the teeth in the socket increases the danger of general infection. "The elastic nature of the periodontal membrane makes it possible for the teeth to bear the shock of mastication but the same elasticity favours the transmission of infection. If there is infectious material around the tooth, the strain of mastication forces the tooth downwards so

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[1] *Medical World*, December 4, 1913, p. 688.

that the root acts as a plunger, injecting the septic matter into the surrounding tissue.''

In periodontal disease the area from which absorption can take place is often extensive; the destruction of the bony socket to a

Fig. 697.

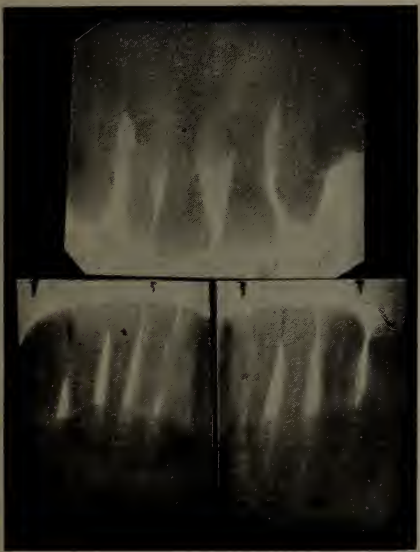

Fig. 698.

depth of an eighth of an inch around each tooth would be equivalent to an exposed area of about $2\frac{1}{2}$ square inches.

In cases where the disease has been extremely chronic the teeth

become very brittle. This fragility is probably due to increased calcification of the soft parts of the dentine and cementum, and the

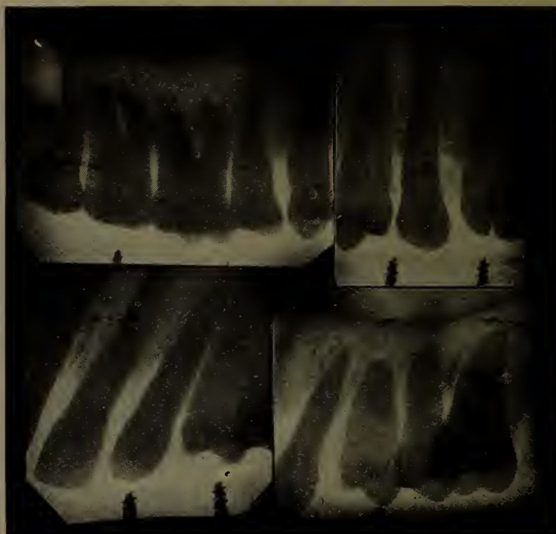

Fig. 699.

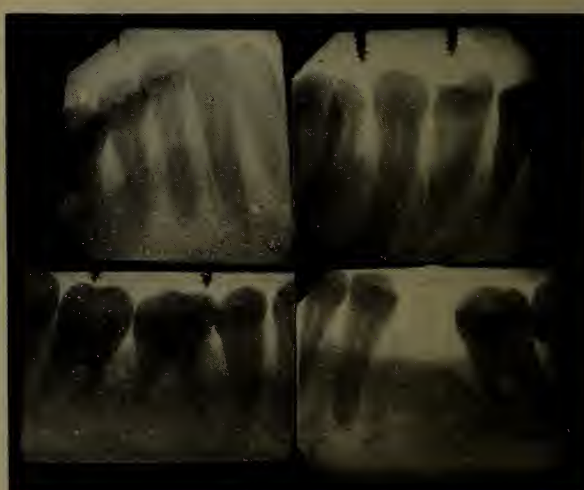

Fig. 700.

process is as follows: The toxins injure the tooth tissues, which, like other tissues of the body, react, the reaction taking the form

of an increased calcification of the soft contents of the dentinal tubes and cemental lacunæ, thus causing greater fragility of the tooth, and rendering the tooth more brittle. On being held to the light such teeth appear more translucent than normal teeth, especially about the apices, and if the teeth are immersed for six

Fig. 701.

or eight weeks in borax carmine it will be found that the translucent area does not stain to the same extent as the other parts of the teeth, which indicates that the soft tissue normally present has undergone calcification.

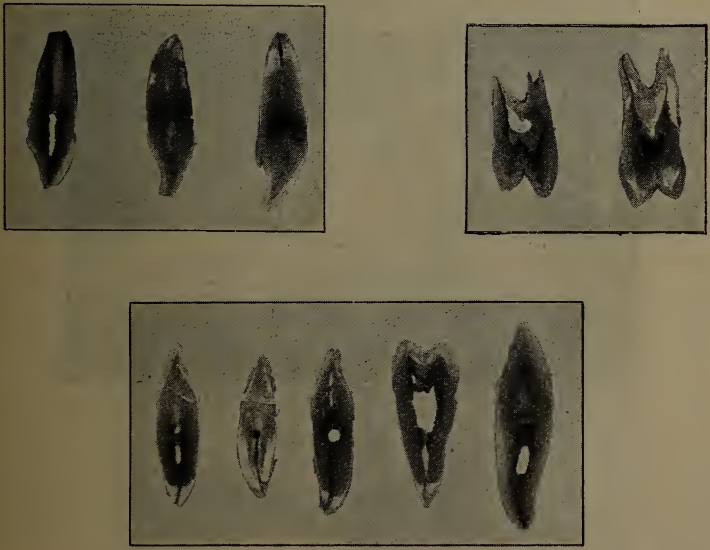

Fig. 702.
Teeth from cases of periodontal disease showing translucent areas.

Sections of teeth from three cases of periodontal disease are shown in fig. 702.

In **animals** that have been the subjects of this disease exactly similar changes are to be found in the bones, but the teeth show

greater deposits of calculus owing to the absence of the system of artificial cleaning adopted by human beings, and recent specimens often show the spaces between the teeth choked up with food débris.

The following specimens show the different stages of the disease in animals:—

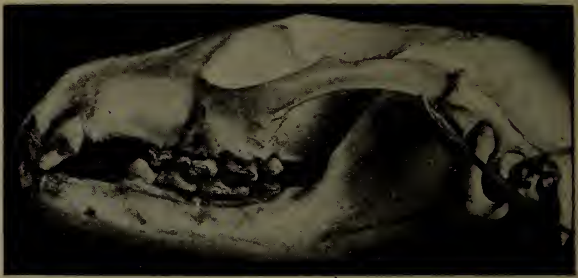

FIG. 703.

FIG. 704.[1]

Fig. 703 is the skull of a Chinese palm-civet (*Paradoxurus larvatus*), and shows the cupping of the sockets, the result of rarefying osteitis.

The next specimen (fig. 704) is one from a Panolia deer (*Cervus eldii*); the destruction of the bone is most marked in the region of the molars where the food is most likely to lodge.

Fig. 705 is a specimen of a spotted hyæna (*Hyæna crocuta*), and shows very clearly the marked destruction of the alveolar process

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[1] From *Trans. Odonto. Soc.*

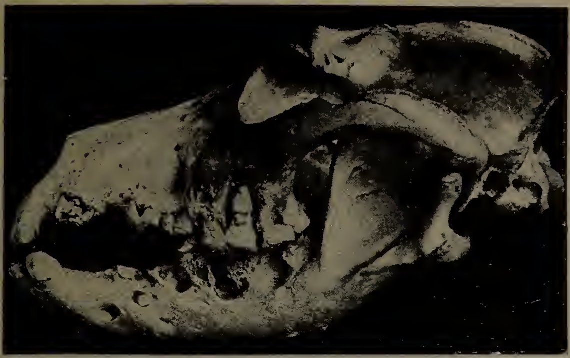


FIG. 705.[1]

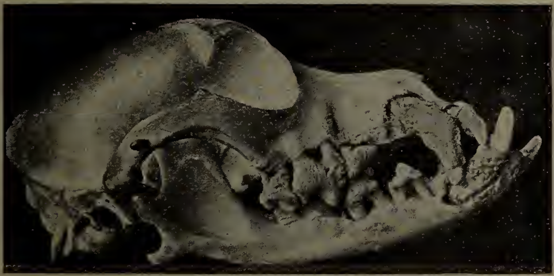


FIG. 706.[1]

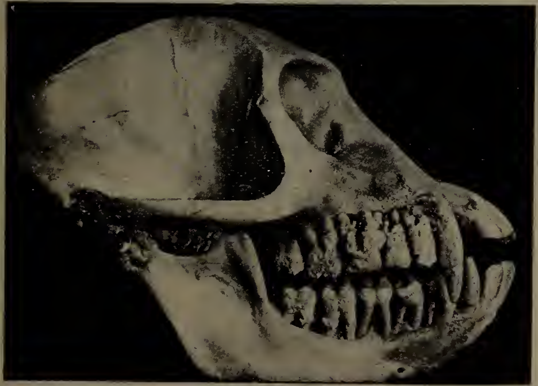


FIG. 707.[1]

[1] From *Trans. Odonto. Soc.*

from rarefying osteitis. This is the stage at which the teeth are almost on the point of dropping out.

An example of this disease in a domestic dog (*Canis familiaris*) is shown in fig. 706, and the specimen is a fair sample of the mouths of many of these animals.

Fig. 707 shows an advanced state of the disease in a Vervet monkey (*Cercopithecus lalandii*).

× 80.

FIG. 708.[1]—In this section the infiltration of the gum margin with leucocytes is seen. At (*h*) the epithelium is destroyed; (*y*) epithelium commencing to disintegrate. The bone is normal.

The conclusions to be drawn from an examination of skulls showing the disease are:—

(1) That the bone lesion is a progressive rarefying osteitis commencing at the margin of the alveolar process, and (2) that the rate of destruction is in proportion to the density of the bone.

[1] From *Journ. Brit. Dent. Assoc.*

Microscopical investigation of the tissues in the various stages of this disease has not been carried out to any considerable extent. A useful paper was published by Znamensky.[1] This author records the result of his examination of sections obtained from a female aged 39 who had suffered from pyorrhœa alveolaris. The patient died of acute anæmia, the result of hæmorrhage after parturition. The decalcification of the preparations was accomplished by means of a 3·5 per cent. solution of trichloracetic acid. Some of the sections were stained with eosin and hæmatoxylin and others in

i
c
y

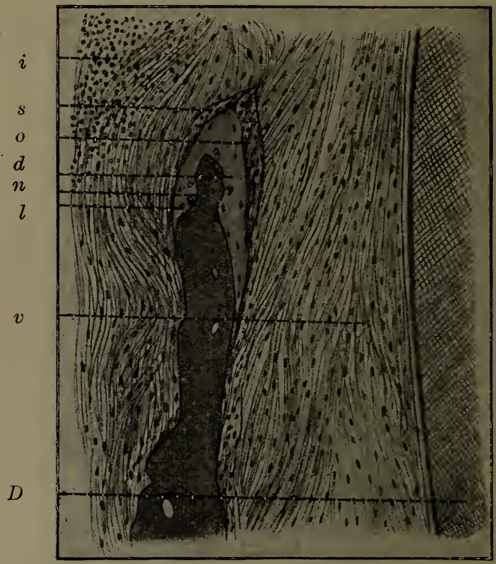
× 80

FIG. 709.[2]—This section shows that the inflammatory process proceeds from the periphery, namely, from gum towards the bone. (*i*) gum infiltrated with leucocytes; (*c*) normal gum; (*y*) normal bone.

Loeffler's blue, and the sections were afterwards mounted in Canada balsam. The series of sections showed the progressive development of the pathological process. In all the sections a deposit of calculus was present under the gum margin. The sections showed that the pathological process was of an inflammatory character,

[1] *Journ. Brit. Dent. Assoc.*, vol. xxiii, p. 585.
[2] *Journ. Brit. Dent. Assoc.*

originating in the gum, and then successively involving the periodontal membrane and the adjacent bone and finally causing their destruction. The destructive process in the bone near the margin of the socket consisted in the decalcification of the bone and its transformation first into an osteoid tissue and afterwards into a fibrous intervening tissue which subsequently became infiltrated with leucocytes. In the part of the socket where the bone-marrow was present lacunar absorption of the bone was seen.



× 180.

FIG. 710.[1]—In this specimen the implication of the bone in the disease is shown. (*i*) infiltration approaching from the gum towards the bone; (*s*) bone transformed into fibrous intervening tissue; (*o*) osteoid tissue; (*d*) bone partially decalcified; (*n*) bone corpuscles; (*l*) line dividing the healthy from the unhealthy bone; (*v*) periodontal membrane; (*D*) dentine.

The whole process was in the nature of a rarefying inflammation (see figs. 708 to 712).

E. S. Talbot[2] has examined the patho-histology of the disease in a series of dogs and has shown that the earliest manifestation is in the gingival margin, and that with the progress of the disease both the periodontal membrane and the bone become involved.

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[1] From *Journ. Brit. Dent. Assoc.*
[2] "Interstitial Gingivitis."

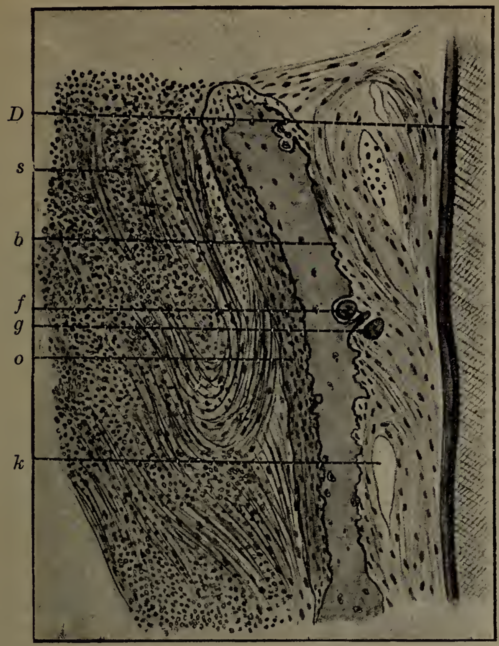
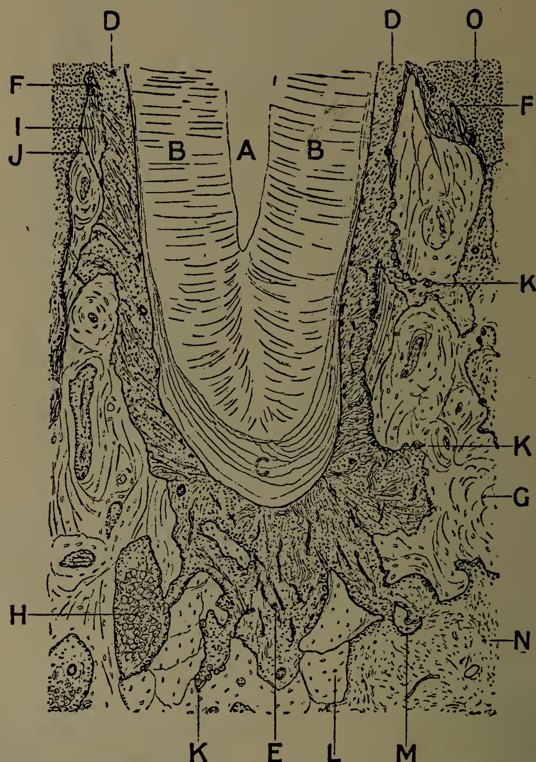


FIG. 711.—*o*, outside of the tooth socket being connected with osteoid tissue; *b*, inside of the tooth socket showing Howship's lacunæ; *g*, osteoclasts; *f*, the so-called lacunar absorption of the bone is proceeding; the blood-vessels of the periosteum, *k*, are dilated, but the periosteum is but little infiltrated, the gum, on the contrary, showing considerable infiltration; *s*, reaching the bone of the socket; *D*, dentine. Magnified 180 times.

FIG. 712.—This section shows the concluding stage of the development of the disease in the marrow part of the bone; bony laminæ are absorbed and transformed into fibrous connective tissues very strongly impregnated with inflammatory infiltration. There is a sequestrum (x) to be seen which is beginning to be absorbed from the periphery. Magnified 360 times.

The absorption of the bone is at times rapid and takes place by (*a*) lacunar absorption; (*b*) the formation of perforating canals; and (*c*) halisteresis (disappearance after prior absorption of lime salts).



(From a drawing by Mr. A. Hopewell Smith)

FIG. 713.[1]—(A) Pulp cavity; (B) dentine of tooth; (C) hyperplasic cementum around apex of root; (D) periodontal membrane, greatly thickened—hyperplasic; (E) indifferent tissue at apical region greatly increased in amount; (F) free edge of bone of socket becoming converted into fibrous intervening tissue; (G) bone of socket presenting earliest signs of osteoporosis; (H) large osteoporotic space in bone of jaw filled with bone-marrow; (I) bone of socket partially decalcified and converted into osteoid tissue; (J) junction of living with decalcified bone; (K) osteoclasts producing lacunar absorption; (L) bone of jaw only slightly altered by disease; (M) sequestrum undergoing peripheral absorption; (N) soft, cancellous tissue slightly changed from normal; (O) inflammation of gum at neck of tooth.

The main features of the condition of the bone are well shown in fig. 713—a section taken from the human subject.

[1] From *Lancet*.

(C) CLINICAL APPEARANCES

In a young adult whose mouth is in a normal condition, the gums fit closely around the necks of the teeth and the spaces between the teeth are filled with tags of gum. In the earliest stage of periodontal disease these tags of gum become slightly congested, and, if a probe is passed into the inter-proximal spaces, it will be found that the gum has been partially destroyed. The congestion gradually extends to the whole of the margins of the gums which then bleed readily. Next, the tags of gum between the teeth gradually disappear and the normal festoons are obliterated. At this stage an examination of the teeth will usually disclose the presence of particles of food and other débris in the approximal spaces and small nodules of calculus on the teeth. Lastly the inflammatory process involves the bone which, together with the periodontal membrane, is slowly destroyed. The gums recede, but the recession does not ordinarily keep pace with the destruction of the alveolar process, and the result is that around the teeth deep pockets are formed in which pus and other morbid material accumulate and aggravate the condition. The mucous membrane is now deeply congested, the free margins of the gums are swollen and bleed at the slightest touch. The roots of the teeth are more or less exposed and are covered with a layer of hard greenish-brown calculus; there is a fœtid discharge and the breath has a repulsive odour which is due to indol-forming organisms. A sickly, sour odour of the breath is noticeable when yeasts and bacteria causing carbohydrate fermentation are present. The teeth are freely movable and may become so loose that they can easily be removed. If the disease is left untreated the teeth are lost one by one, and with the loss of the teeth the inflammatory process completely clears up.

The disease, especially in advanced cases, is usually associated with congestion of the tonsils and of the mucous membrane of the mouth and pharynx, and it is often accompanied by superficial glossitis. The patient experiences an unpleasant taste in the morning. There is frequently recurring hæmorrhage from the gums, which is swallowed during the day, but occasionally escapes from the mouth at night and stains the pillow. The last symptom deserves special attention, as there is some danger that it may be mistaken for hæmorrhage from the lungs.

The **clinical appearances of the disease,** which **vary considerably,** are determined by the general condition of the patient, the resistance of the tissues, and the hygiene of the mouth. At one

period the condition may be acute, with a free flow of pus from the teeth sockets and a rapid destruction of the tissue. This state may be evanescent and may be followed by a period during which the inflammation is more or less quiescent. In some cases the teeth are comparatively free from calcareous deposits; in others they are completely coated. The disease may be more active around the anterior than around the posterior teeth, or vice versa. Again, the destruction of tissue may be more active in one region of the mouth than in another, e.g., the destructive process is often more advanced on the palatal than on the labial aspects of the incisors and canines.

In severe cases the disease may spread in the maxilla to the maxillary sinus, or in the mandible to the body of the bone.

"The buccal mucous membrane in advanced cases shows a number of small white stellate points, somewhat hard and shotty, lying underneath the mucous membrane, and corresponding in position to the site of the disease of the gum margin. From these glands bacteria of various species, generally bacilli, may be obtained" (Goadby).

In some cases, where care is taken by the patient to keep the mouth clean, the gums are not sufficiently abnormal in colour to attract attention and the looseness of the teeth is the only indication of the presence of the disease. In such cases the probe will disclose deep pockets and pressure on the gum will cause a discharge from the tooth sockets. In a few cases the disease is slow in its progress, and the surrounding bone actively reacts to the injuries caused by the toxic products in the sockets. This is well seen in the case shown in fig. 714.

In certain cases there seems to be a tendency for granulation tissue to form, causing the condition to simulate sarcoma. In one case under observation, associated with myxœdema, the gums were friable and presented a translucent appearance.

The disease may often be well advanced without the patient having become conscious that anything is wrong, the only symptom being a tendency for the gums to bleed readily, and this is often unheeded by the patient. With the formation of spaces between the posterior teeth, neuralgia may arise from septic infection. In the later stages there is often persistent neuralgia owing to the main trunks of the nerves being involved in the diseased process. Where pus formation is active the patient will often complain of a general itching of the gums.

Whether the disease can be transmitted from one individual to another is an open question, but the balance of evidence is rather against it.

Clinical appearances alone are not altogether satisfactory guides as to the extent of the disease, and it is only by the aid of skiagrams that the amount of the bone destruction can be estimated with any

FIG. 714.—From a case under the care of J. G. Turner. Compare with fig. 693.

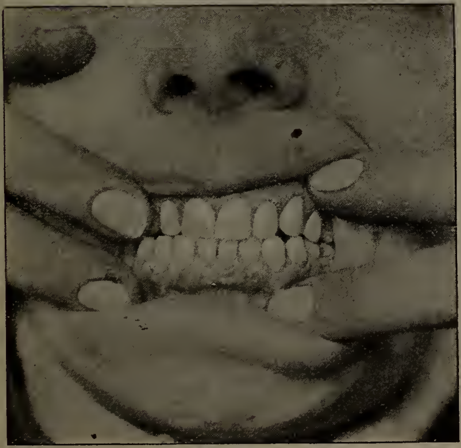


FIG. 715.

degree of accuracy. The following cases will serve to demonstrate the amount of bone destruction in relation to the clinical appearances.

The case shown in fig. 715 depicts an early stage of the disease. Clinically there is no recession of the gums beyond a partial disappearance of the interdental papillæ between the lower incisors. There was a marked marginal gingivitis, together with a congestion of the whole of the gums. There was a free discharge from the pockets around the teeth. This patient had a well-developed arch and there was marked attrition. The skiagrams show that the alveolar process is already involved and that the destruction of bone has advanced to a considerable extent in the lower incisor region (fig. 716).

FIG. 716.—Skiagrams of the case shown in fig. 715.

In the case shown in fig. 717 the clinical appearances suggest that the disease is more advanced than in the preceding case. The muco-periosteum was more swollen and congested. The interdental papillæ have quite disappeared, but the gum margin on the labial aspects of the teeth just fails to cover the necks of the teeth. The skiagrams fig. 718 show that the bone destruction is much more advanced than the gum recession.

Fig. 719 illustrates an advanced condition. The skiagrams show the extensive destruction of the teeth sockets. Those marked (*a*) and (*b*) also illustrate a point, namely, that the calculus only extends to just under cover of the gum margin. Rarefying osteitis

around the roots of a maxillary molar is shown at (*c*) (fig. 720). This case illustrates some features which are of interest from the point of view of prognosis. The patient, a man aged 34, was a

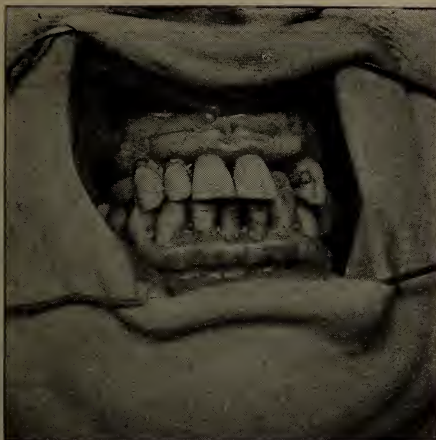


FIG. 717.

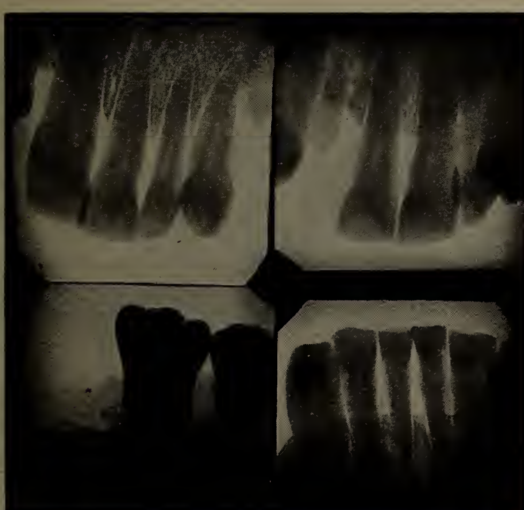


FIG. 718.—Skiagrams of the case shown in fig. 717.

compositor by trade, and was subject to dyspepsia. Beyond a well-defined marginal gingivitis the gums were normal in colour and firm in consistency. The teeth were smothered with calculus; the

gum margin was above the necks of the teeth, and the interdental papillæ had disappeared.

In the case shown in fig. 721 the patient was a mouth-breather and complained of bleeding from the region of the mandibular

Fig. 719.

(c)

(a)

(b)

Fig. 720.—Skiagrams of the case shown in fig. 719.

incisors. The teeth had been regularly cleaned. The gums were well up to the level of the necks of the teeth, and the interdental papillæ were not destroyed. There was marked gingivitis around

the mandibular incisors where pus was present. An examination with a probe showed that there was extensive destruction of the alveolar process in the region of the mandibular incisors, while in the rest of the mouth the bone was unaffected.

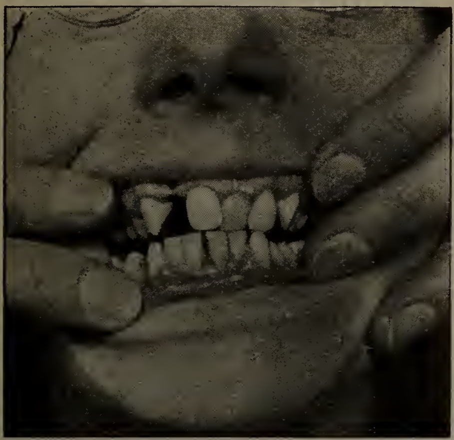


Fig. 721.

Mandibular incisors

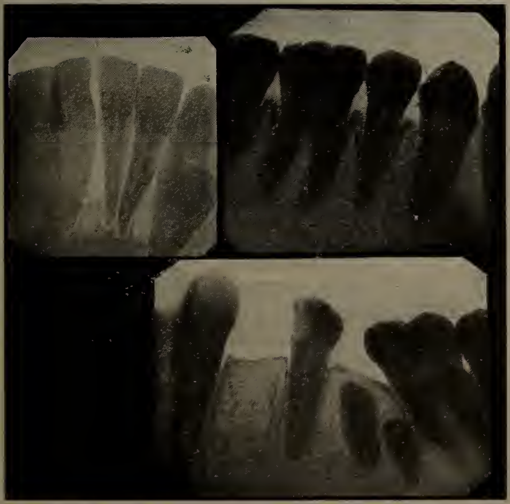


Fig. 722.—Skiagrams of the case shown in fig. 721.

In the case shown in fig. 723 the alveolar process on the mesial aspect of the lateral incisor has been completely destroyed, and infection of the bone around the apices of the lateral and central

incisors has followed. This patient presented a well-defined dento-alveolar abscess, with the pulps of the teeth alive.

(D) SEQUELÆ.

The various local and general sequelæ that may arise from the presence of sepsis in the mouth are discussed in chapter XXV. But there is one point upon which particular stress must be laid here, and that is that the *absence of objective symptoms is no proof that damage—and possibly irreparable damage—is not in progress.* Patients will carry pus in their mouths for years without apparent harm, but eventually general symptoms may appear. The following case is typical:—

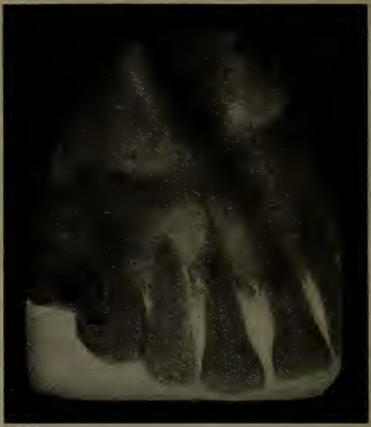


Fig. 723.

A man, aged about 36, at the beginning of 1909 developed a swelling in the left maxilla, and examination of the mouth showed slight necrosis in this region with general suppurative periodontitis, necessitating the removal of all the teeth. This was the previous history of the patient: his normal weight was about 13 stone, he was an exceptionally fine type of man and had succeeded in carrying off many prizes in important athletic military contests. About the beginning of 1907 he discovered that he was losing weight, and in February, 1909, he weighed only about 9 stone. During this period his mouth had, he said, caused him very little trouble, except that he had neuralgia occasionally, and his teeth had from time to time become loose. All his teeth were eventually removed, and a rapid improvement in his general condition followed. On questioning this patient a very definite history of periodontal disease spreading over a dozen years was obtained.

This patient had, unknown to himself, been the subject of periodontal disease for years, and for a long period he had been

able to combat the absorption of the toxic matter, probably by the production of antibodies, and so remain immune. After a time this immunity had broken down and the toxic material became rapidly destructive to the tissues.

(E) PATHOLOGY

Considerable light has been thrown on the pathology of periodontal disease by studying the disease in animals.

(1) Horses.—In the course of an examination of nearly 500 skulls of horses which had worked in London it was found that approximately one-third presented some degree of periodontal disease, ranging from a slight destruction of the gingival margin to the most aggravated form of the disease.

The first sign of mischief is a slight injury to the gingival margin, resulting in the destruction of the muco-periosteum filling

Fig. 724.[1]—Portion of maxilla of horse, showing destruction of the bone around the teeth. The disease is most marked in the neighbourhood of the first molars.

up the intervals between the teeth. These spaces are usually seen in the maxilla on the buccal side and in the mandible on the lingual side. In the spaces formed, food, &c., collects and undergoes fermentation, leading to the destruction of the adjacent tissues, so that in time a marked space is formed between the teeth into which fodder or other material may become firmly wedged (figs. 724 and 725). As the disease progresses the periodontal membrane becomes more and more involved, leading to extensive destruction of the bone; the teeth loosen, and the infection spreads in the

[1] From *Trans. Odonto. Soc.*

maxilla to the antrum, setting up suppuration, and in the mandible to the body of the bone, causing an abscess.

If a horse in which the disease is advanced be examined, the muco-periosteum is seen to be inflamed and thickened (see fig. 726) and a profuse muco-purulent discharge will be noticed around the teeth, the breath being extremely offensive. The mandible is much

FIG. 725.[1]—Portion of the mandible of a horse showing food packed between the teeth.

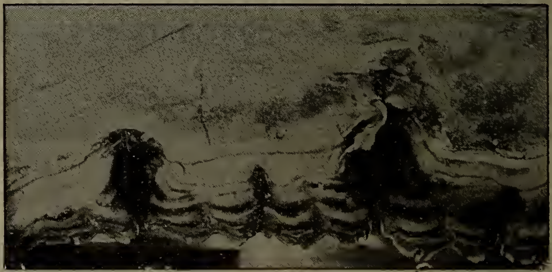


FIG. 726.[1]—Portion of the mandible of a horse with the muco-periosteum in position. The effect of the food packing in the soft tissues is well shown.

more liable to attack than the maxilla, and, as far as my own observations go, more spaces are met with between the anterior premolars than between the molars, but the spaces formed between the premolars do not apparently set up the same amount of trouble as those found towards the back of the mouth. In the maxilla

[1] From *Trans. Odonto. Soc.*

spaces seem to occur with the greater frequency towards the back of the series. As a result of the spaces the teeth become painful to pressure, and the function of mastication is interfered with, leading in many cases to marked irregular wear of the teeth. In some cases only one or two spaces are seen, in others huge gaps occur between nearly all the teeth.

The incisors may be attacked by periodontal disease. The effect on the incisors is very similar to that seen in the human subject; the alveolar process disappears; the teeth loosen, become forced out of place, and are finally lost.

The facts that the spaces start on the buccal sides of the upper teeth and on the lingual aspects of the lower teeth and that the bone destruction is greatest in the region where the food is most liable to collect, would seem to suggest that food lodgment plays an important part in the causation of the disease.

In the horse the disease would seem to be mainly local in origin. The injury of the muco-periosteum is probably due to foreign bodies

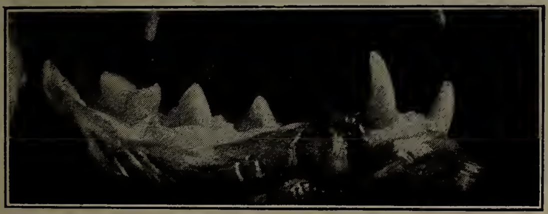


Fig. 727.—Normal gums in a cat.

in the diet. It may arise from food, prepared in the form of chaff or grains of corn, becoming wedged in the "gingival trough." To the fermenting food in the spaces, infection is added from organisms present in, or introduced into, the mouth and from the toxins so produced the tissue destruction proceeds. With the loss of the teeth a nidus for the accumulation of débris, &c., no longer exists, and healing occurs.

(2) Cats and Dogs.—Amongst domestic cats and dogs periodontal disease is extremely prevalent. H. Gray, a veterinary surgeon who has a considerable experience of the disease in these animals, is of the opinion that in cats it is most frequently seen in the highly bred pet animals that are fed on soft food; the ordinary domestic cat fed on a meat diet keeping comparatively free from the disease. The explanation is that the soft diet clings about the teeth, stagnation areas are formed, and a marginal gingivitis results. Such a condition is well shown in figs. 727 and 728.

Amongst dogs the disease is seen most often in the pampered lap dogs, and in the short-muzzled breeds, such as the pugs and bull dogs, more especially in the non-functional teeth, namely, the incisors. Dogs living on a flesh diet, which gives plenty of exercise to the jaws, are invariably free from the disease.

Amongst cats and dogs, therefore, the disease is evidently closely connected with the soft pap diet which clings about the teeth, and ferments and injures the gingivæ.

(3) Wild Animals.—In animals kept in captivity periodontal disease is of frequent occurrence, and the Museum of the Royal College of Surgeons of England contains an excellent series showing the disease in a wide range of animals, i.e., herbivora, rodents, marsupials, monkeys, the small carnivora, &c.

It will be noticed that in the skulls of captive animals affected by the disease the bone destruction is usually most advanced around the areas where the greatest force of mastication is exerted and

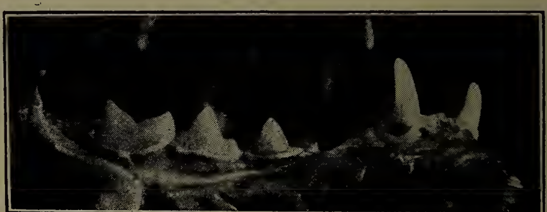


Fig. 728.—Marginal gingivitis in a cat.

consequently where the soft tissues surrounding the teeth are most likely to be injured. The frequency of the disease in captive animals and the comparative immunity of animals in the wild state, taken in conjunction with the limitation of the disease to the masticating area, point to the disease being closely associated with the character of the food given to captive animals. This food is generally of a softer character, needing less rending and tearing than the food which the animals would obtain in the wild state, consequently, the teeth are less used and the natural cleansing operations are not performed. When captive wild animals are given food of a character similar to their natural food, as in the case of the large carnivores which are fed on a diet of fresh meat, they are almost entirely free from the disease.

The study of the disease in animals would seem to show that it is purely local in origin, that is, it is due to food lodgment; the lodged food undergoes fermentation and putrefaction and the tissues are damaged. This view is supported by the condition of the gums and teeth of cattle in parts of America, where owing to the pene-

tration of the tissues by the barbed crowns of *Hordeum jubatum*[1] destruction of the teeth sockets occurs and the teeth are lost. G. Thomson[2] states that periodontal disease is common in horses running almost wild in countries liable to prolonged drought. The animals under these conditions dig up roots, and in chewing the grit and sand injure the gums and start periodontal disease.

(4) Man.—There are one or two important clinical facts in connection with the disease in man which may assist in the endeavour to trace the pathology of the disease. In *non-mouth-breathers* the disease commences in the molar region and gradually spreads to the anterior teeth, while in *mouth-breathers* the disease commences at an earlier date and often remains for some period limited to the anterior teeth. The commencement of the disease in the *non-mouth-breathers* occurs in the region where lodgment of food is liable to occur, and probably here the initial lesion is an injury to the gingivæ from food débris.

The fact that in *mouth-breathers* the disease commences in the incisor region is instructive. If the mouth of a child affected with mouth-breathing, but with functional molars, be examined, a gingivitis will be noticed limited to the incisor teeth, especially the mandibular ones. The absence of gingivitis in the molar region is due to the fact that the function of this part of the mouth is being properly performed; the friction of mastication and possibly the rubbing of the buccal mucous membrane against the gums removes the superficial layers of epithelium, and stimulates a healthy reaction in the tissues. In the front of the mouth the normal friction of the lips against the gums is absent; the surface epithelium accumulates together with the débris of food and micro-organisms, and injury results to the gingivæ. As long as mouth-breathing continues the gingivitis persists owing to the constant injury, and eventually the periodontal membrane becomes involved. There is little doubt, therefore, that, with mouth-breathers, the initial stage of the disease is a localized injury to the gingivæ of the anterior teeth.

In considering the pathology of this disease, due weight must be given to *the degree of resistance of the osseous tissue*, as it probably plays an important part in the rate at which the disease progresses. An examination of dried specimens certainly suggests that the more compact the osseous tissue the greater the barrier to the spread of the disease. The question then arises whether the tissues of the tooth socket are as resistant to disease as we

[1] "Dental Surgery," by Tomes and Nowell, p. 648.
[2] *Trans. Odonto. Soc.*, vol. xxxviii, p. 76.

might naturally expect them to be. Although no definite data bearing on this point exist, there are certain phenomena which tend to show that the tissues in many people lack normal resistance. It is an axiom that to maintain a part in health the function of that part must be maintained. There is little doubt that in modern times the teeth and surrounding tissues are not called upon to perform their normal functions, with the natural result that the tissues are deprived of a normal blood supply and consequently suffer in vitality. The bone surrounding the teeth is, as we know, a tissue of transient structure, depending for its very existence on the teeth themselves. It is therefore reasonable to assume that there is a very close relationship between functional activity and the resistance of the tissues. With our present diet, this function is not properly brought into play, as a very small amount of mastication is necessary with foods prepared as they are to-day. This loss of the function of the teeth must seriously affect the structure of the bone forming the alveolar process, and render it less resistant to attack. Clinical observation supports this view.

In mouths which show that the function of mastication is duly performed, the alveolar process is well developed, and if such mouths are attacked by periodontal disease the progress of the disease is not rapid. On the other hand, in individuals who masticate imperfectly, the bony coverings of the teeth are thin and sparse, and the disease when once started progresses rapidly. An examination of maxilla and mandible will confirm this statement, the roots being found in places quite bare of bone, and yet showing no sign of inflammatory changes. It seems probable, therefore, that imperfectly formed teeth sockets play an important part in the progress of the disease, inasmuch as their power of resistance is considerably diminished.

There is another point to be considered in connection with the resistance of the bone, viz., that *any inimical condition affecting the osseous system is likely to show itself in the alveolar process at an early age*, the reason being that, as pointed out above, the alveolar process is a transient structure.

(F) BACTERIOLOGY

The Relation of Micro-organisms to the Disease

Parasitology

A cover-slip preparation made from a case of periodontal disease will reveal a heterogeneous assortment of organisms. In fig. 729 such a preparation is presented, under the dark ground illumination,

and W. J. Penfold, who kindly examined the slide, has identified the following types of organisms:—

(1) Treponemata of *macrodentium* and *microdentium* varieties, so-called spirochætes of the mouth.

(2) Vibrios and spirillary forms.

(3) Bacilli in great variety.

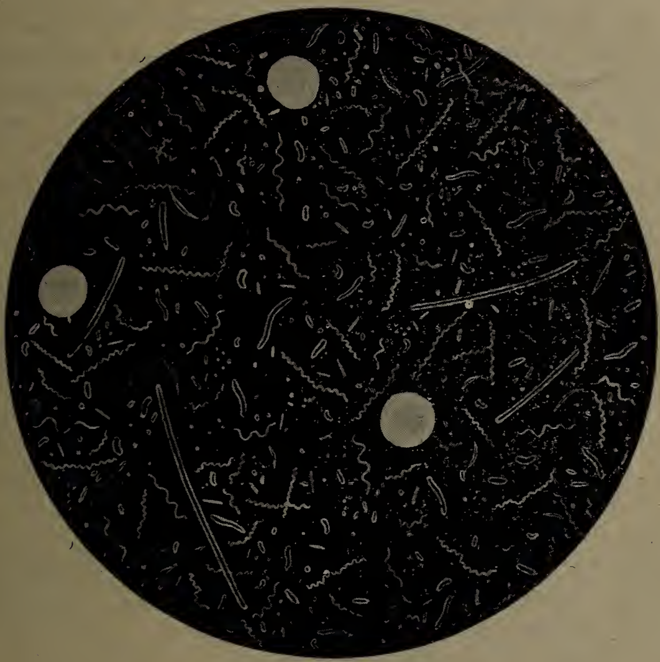


FIG. 729.

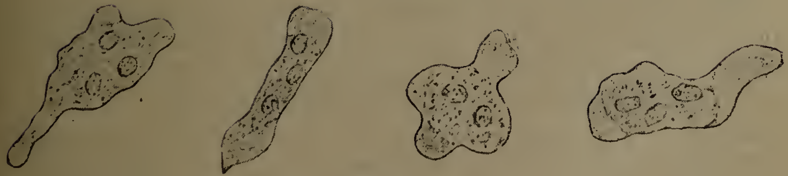


FIG. 730.

(4) Filamentous forms.

(5) Cocci of various sizes, the grouping of which cannot be determined without cultivation methods.

The large round bodies in the preparation are blood cells.

The discharge from the same pocket was examined by means of transmitted light and revealed the presence of *Entamœbæ buccalis*. A drawing of four stages of one amœba is reproduced in fig. 730.

In a paper published in the *Dental Record*,[1] F. E. Taylor suggests a classification of organisms associated with periodontal disease under four headings:—

(1) Leptothrices, (2) Spirochætes, (3) Amœbæ, (4) Bacteria.

(1) *Leptothrices.*—These organisms have recently been studied by Goodrich and Moseley.[2] They grow in several forms—as threads, as coccoid bodies, as flower heads, as a bottle-brush shaped form, and as fusiform bodies. They are found in profusion in the pockets and on the teeth removed in the treatment of the disease.

(2) *Spirochætes.*—The most important work on spirochætes in connection with periodontal disease has been done by Drew and Griffin.[3]

They found at least six species, viz., *Spirochæta buccalis*, *S. Vincenti*, *S. refringens*, *Treponema macrodentium*, *T. microdentium* and *T. mucosum.* The authors adopt the term Spirochæte for an elongated sinuous organism provided with an undulating membrane but possessing no flagella, the term Treponema for a sinuous organism with no undulating membrane but with terminal flagella.

In addition to the above the authors noticed two flagellate organisms which they believed had not been previously described, one of these organisms bearing a striking resemblance to the trypanosomes.

(3) *Amœbæ.*—Recently Barrett and Smith, Bass and Johns, and others have called attention to the frequency of the association of amœbæ with pyorrhœa alveolaris, and it has been claimed that the cause of periodontal disease is *Entamœba buccalis.* In 1849 Gros first observed amœbæ in the mouth. Sternberg (1862) found them in the sordes about teeth.

The active forms of *A. buccalis* are from 6μ to 32μ in diameter; they average about 15μ They have a distinct ectoplasm which is well seen when the organism is in motion. The organism is hyaline and refractile. The endoplasm is granular and shows many food vacuoles, but no contractile vacuole. The nucleus is well defined and shows a thick greenish membrane containing a great deal of chromatin. A small centriole is situated near the centre of the nucleus. The motility is sluggish and the pseudopodia are blunt. The cysts of the organism have never been seen in the mouth.

A causal relationship of *A. buccalis* to periodontal disease was claimed on the grounds that:—

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[1] May 1, 1918.

[2] *Journ. Roy. Micro. Soc.*, October 18, 1916.

[3] *Journ. Roy. Micro. Soc.*, April, 1917.

(1) It was always present in the disease.

(2) The administration of emetin and the application of the drug to the pockets cured the disease.

The points against *A. buccalis* being the cause are that:—

(1) It is frequently found in mouths with healthy gums.

(2) Emetin does not cure the condition, although it may remove the amœbæ if the drug is applied locally.

(3) The *A. buccalis* is not always present.

Indeed, the whole of the evidence brought forward by those who wish to establish its causal relationship with periodontal disease is most unconvincing and it is extremely doubtful whether any such relationship exists.

(4) *Bacteria.* The bacteria present may be Streptococci (always), *Staphylococcus albus* and *aureus*, *Micrococcus catarrhalis*, vibrios, fusiform and other bacilli.

In a series of thirty-three cases recorded by Eyre and Payne[1] the following organisms were regarded as responsible for periodontal disease:—

	Cases.
Micrococcus staphylococcus pyogenes aureus	2
,, *catarrhalis*	9
,, ,, and *Streptococcus pyogenes longus*	11
Streptococcus pyogenes longus	7
,, *lanceolatus pneumoniæ* (pneumococcus)	4

In a recent communication L. S. Medalia[2] gives the results of his study of 115 cases. He found that the organism most frequently met with was the pneumococcus (*Streptococcus lanceolatus pneumoniæ*), 107 times out of 115. The results of his investigation are as follows:—

	Cases.
Pneumococcus strepto-lanceolatus pneumoniæ	26
,, and staphylococcus...	67
,, and streptococcus	3
,, staphylococcus and streptococcus	10
,, and *Micrococcus catarrhalis*	1
Staphylococcus and ,, ,, ...	2
Staphylococcus aureus	2
Streptococcus and staphylococcus	1
Sterile	3

It will be noted that the bacteria found in the pus from cases of periodontal disease are identical with those which are responsible for ordinary suppuration in other parts of the body.

[1] *Proc. Roy. Soc. Med.* (Odonto. Sect.), vol. iii, p. 36.

[2] *Dental Cosmos*, 1913, p. 24.

To sum up, investigations into Parasitology afford no evidence that periodontal disease is caused by a specific organism.

Résumé.

A general survey of the morbid anatomy, pathology, and clinical appearances of periodontal disease leads to the conclusion that the initial lesion in man is injury to the gingival margin, which results in the formation of a stagnation area. In this area material collects from which toxins are formed, and the tissue changes which follow are identical with those produced by periodontal disease in the lower animals. In the area immediately beyond the ulcerating surface—for as such it must be regarded—the tissues react and form a protective barrier, and the progress of the disease is governed by the efficiency of this barrier. The reaction of the tissues depends upon:—

(1) Their inherent vitality.

(2) The degree of functional activity—the greater the flow of lymph through the area the greater will be the accumulation of antibodies.

(3) The severity of the infection.

In many cases of periodontal disease, more especially in young adults, the natural defence of the tissues suffices to prevent the undue absorption of toxins or organisms via the bone. But the discharge from the mouth is swallowed with the saliva and consequently the gastric mucous membrane is continually being damaged. Sooner or later the defence of the tissues at this part breaks down and eventually the whole intestinal tract becomes involved.

The tissues of many patients seem to be incapable of raising an effective barrier even in mild cases. In cases where the natural defences of the tissues around the teeth are inadequate the toxins pass directly into the general circulation.

(G) ETIOLOGY

Considerable diversity of opinion exists as to the cause of chronic general periodontitis.

In reviewing the pathology of the disease in animals it has been shown that the lesion is caused by injury from the food. When cats and dogs are fed on a diet of fresh flesh, their natural food, they are invariably free from the disease, but as soon as soft pap food is substituted the animals become a prey to the disease. In the horse the disease can clearly be traced to injury from the food,

the particular form in which the food is given being responsible for the injury. Under natural conditions horses feed upon grass which is torn up in long strands and in a pliable state, and is masticated and disposed of without injury to the soft tissues. Under "civilized" conditions horses frequently cannot be put out to grass and the food is often given in the form of hay and straw (chaff) cut up into short lengths. Chaff in short stiff lengths is very likely to cause injury to the muco-periosteum through being pressed into spaces between the teeth. This view of the causation of the disease in horses is supported by the fact that the disease is prevalent wherever the conditions are such that fragments of thorn become mixed with the food. Similarly, as previously mentioned, cattle in parts of America are subject to the disease owing to the penetration of the tissues by the barbed crowns of *Hordeum jubatum*. In the horse the disease is clearly to be attributed in a very large measure to the physical character of the food.

In man, too, *the evidence points to the disease being started by injury of the gingival margin from food débris, or by the local action of toxins as seen in the marginal gingivitis of mouth-breathers.*

The prevalence of the disease is probably due to the character of the diet of the present day. Much of our food is now prepared in such a manner that it readily accumulates around the teeth and is of a character which easily undergoes fermentation. The food thus prepared requires but little mastication, with the result that the tissues in and around the teeth are deprived of an adequate blood supply and are thus rendered less resistant to attack[1]. As soon as the disease has started, the formation of abnormal pockets favours the accumulation of débris, thus increasing the basis of infection and so accelerating the action of the toxins.

It is necessary here to consider wherein lies the **difference between caries and periodontal disease**, seeing that both are traceable to the lodgment of food. It is probable that the deciding factor is the predominance of particular foodstuffs. On carbohydrates enzyme action results in the production mainly of lactic acid, while on proteins enzyme action results in the formation of ptomaines which are alkaline in reaction. If we turn to the food

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[1] Evidence in favour of this is shown in a series of skulls of Londoners of the sixteenth and seventeenth centuries. Periodontal disease in the region of the molars is extremely common in the skulls, but the disease is chronic in character and the bone shows distinct reaction to injury. In the majority of these skulls the function of mastication was efficiently carried out as is shown by the attrition of the teeth.

of modern times we notice a very distinct increase in the number of made-up dishes with a corresponding decrease of plain fresh-cooked food. A large proportion of the animal food is imported and has been kept in an ice-bound condition. Such food undergoes putrefactive changes more quickly than fresh animal food.

Attention has been drawn to the intimate **relationship between periodontal disease and mouth-breathing**, and the increase in the number of individuals who are mouth-breathers has, undoubtedly, added to the incidence of the disease.

(H) TREATMENT

In the section on the morbid anatomy and pathology of the disease, it was pointed out that the formation around the teeth of "pockets," which inevitably become stagnation areas, is the outstanding feature of the disease. Until these "pockets" or stagnation areas, have been eradicated, it does not seem reasonable to claim that a cure has been effected, and as it is almost impracticable to eradicate them actual cures of periodontal disease are rare, though well-directed treatment may keep the disease in check. Reference has also been made to the important rôle which mouth-breathing plays in the promotion of the disease. It has also been shown that the progress and severity of the disease is greatly influenced by the degree of resistance offered by the tissues.

Treatment, therefore, should be directed towards promoting efficient drainage, raising the resistance of the tissues and ensuring proper nasal breathing.

With regard to the breathing I am firmly convinced that in all cases of mouth-breathing, even if the patient is addicted to this habit for a few hours a day only, there is very little hope of checking the disease; moreover, in such cases the general symptoms seem more pronounced. It is essential, therefore, to ensure proper nasal breathing. Where the patient breathes by the mouth the nasal cavity must be examined and any obstruction removed. Some patients persist in the habit of mouth-breathing after a free nasal passage has been obtained. The habit can, however, often be overcome by the use of an oral screen. This appliance is made as follows: Models of the teeth and gums are obtained, the models being fixed together with the teeth slightly open at the front, to simulate the relation of the teeth when the mandible is at rest. The necessary dies and counterdies are obtained and a piece of aluminium is struck to fit the surface of the teeth and gums. The

appliance is inserted just before going to rest. The results obtained are most satisfactory.

The **therapeutic measures to be adopted** may be divided into (1) Local and (2) General.

(1) Local Treatment

Local treatment consists in the promotion of asepsis as far as practicable by securing efficient drainage. Efficient drainage relieves the tissues of the constant injury arising from the toxic matter around the teeth and the tissues react more readily. It may be confidently affirmed that the more thoroughly the pockets are kept free from sepsis, the greater will become the prospects of staying the progress of the disease. In theory efficient drainage would seem an easy matter to establish; in practice, however, such is not the case. The local remedies employed should be directed towards:—

(*a*) Freeing the teeth from salivary calculus and other débris.
(*b*) Reducing the depth of the pocket.
(*c*) Cleansing the pocket.
(*d*) Massage of the gums.

(*a*) The removal of salivary calculus allows the pockets to drain more freely and facilitates irrigation of the pockets. The scaling must be done thoroughly and special care taken to remove any calculus in the interstitial spaces. Where there is much gingivitis it is advisable to delay the scaling until the gingivitis has been reduced by appropriate treatment, and the general resistance raised by improving the general health. The operation of scaling can then be carried out more efficiently and with less laceration of the tissues.

(*b*) In considering methods for reducing the depth of the pockets, it must be remembered that the pockets are deepest at the most inaccessible parts, i.e., in the interspaces. The regular use of astringents will often produce good results. Tannic acid in the form of a powder may be used and should be rubbed into the gums for two minutes once a day, the treatment being continued for at least two months. If at the end of this period the gum margins have shrunk, the application may be reduced from once a day to twice a week. As tannic acid is liable to leave an indelible stain on linen, patients using it should be warned against wiping their hands on linen.

The free removal of the redundant gum with scissors and small knives is an excellent method of reducing the depth of the pocket,

especially where there is considerable destruction of the membrane on the labial aspects. The actual cautery is another useful method of destroying the gum margins; this method is especially useful in the interproximal spaces.

(c) Regular cleansing of the pockets and interproximal spaces by the patient is an essential part of the local treatment. First, the spaces between the teeth must be freed of food débris by means of "floss silk"; the gums should then be well squeezed between the thumb and first finger with a downward pressure on the upper teeth and an upward pressure on the lower teeth. The next step is to "irrigate the pockets." If the irrigation can be easily carried out no special fluid is necessary and a free flushing with sterilized water would be effective. The most efficient method is to flush the pocket with peroxide of hydrogen (vols. x), using a hypodermic syringe. The needle of the syringe is passed well into the pocket and gentle pressure exerted. The use of force is to be deprecated as it is essential that any granulation tissue that may be present should not be broken down. But as a hypodermic syringe cannot be readily manipulated by patients it is generally necessary to try an easier, if less efficient, means of irrigation.

A good plan is to have the pockets wiped out with a wisp of cotton-wool dipped in hydrogen peroxide, the cotton-wool being wound round a fine broach. It is necessary to give patients very precise instructions. The broach should be of the type ordinarily used for root canal dressings. The method of winding the wool on the broach should be demonstrated. The following plan is suggested. Spread a wisp of cotton-wool along the palmar surface of the terminal phalanx of the first finger of the left hand; place the broach on the centre of the wool; fold the cotton-wool over the broach; bring the thumb on to the broach and then run the thumb with the broach up the palmar aspect of the first finger; the fragment of wool over the point should then be turned down so as to prevent the point sticking through.

Such detailed instructions may seem hardly necessary, but experience teaches that the success of this method of treatment depends in a large measure on the skill of the patient in twisting the wool on to the broach.

The patient should be shown exactly where and how to apply the peroxide of hydrogen and instructed to pay special attention to the irrigation of the spaces between the posterior teeth. The hydrogen peroxide to be used should be poured into a small receptacle, and any left unused should be thrown away and not returned to the bottle. The pockets should be cleansed at least

once a day, the best time being shortly before retiring for the night. If the patient will only carry out this method of cleansing the spaces thoroughly and regularly, a marked improvement may be confidently anticipated.

(*d*) Massage of the gums by regular rubbing with the fingers and with the tooth-brush will assist in improving the condition of the gum margins.

(2) General Treatment

General treatment, directed towards the removal of systemic intoxications, and a general improvement in health. The nearer the health approaches to the normal standard the greater becomes the resistance of the tissues and their power to react. An impairment of the general health implies a lowering of the resistance of the tissues and of their power to react, and it is very important therefore that steps should be taken to improve the general health as far as possible. But this part of the treatment belongs to the province of the general medical attendant.

Vaccine-therapy has been freely used during recent years. This method of treatment aims at assisting the tissues to defend themselves against the action of bacteria and their products. The method of procedure suggested by J. W. Eyre[1] is as follows: "The patient is instructed to grasp the lip opposite the affected teeth with the forefinger and thumb of each hand and draw it away from the gums; in some cases a small roll of absorbent cotton-wool is packed into the sulcus between the alveolar process and the lip. The gum margin is next wiped with a sterile swab of cotton-wool mounted on the end of a stick, and the gum itself dried with a second sterile swab. Then with another swab firm pressure is made on the gum over the root of the tooth. The first drop or two of pus that exudes is mopped up with a third sterile swab and the pressure continued, and the pus that next exudes is collected on still another sterile swab, or by means of a stout platinum needle. This pus is employed for the purpose of making coverslip films. Finally, more pus is expressed in a similar way and used to inoculate tubes of nutrient media."

The most satisfactory method is to extract a tooth when this is practicable, for preference a molar, and take a culture from the space between the roots or from near the apex of the tooth. Pure cultures of the various micrococci present are then obtained secundum artem. The patient's serum is next examined with a view of

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[1] *Proc. Roy. Soc. Med.* (Odont. Sect.), vol. iii, p. 34.

obtaining evidence of the presence of antibodies to some or any of the organisms isolated which would indicate actual and active infection. In this connection, opsonins, amboceptors, and agglutinins are the most useful antibodies, in the order mentioned. The organism towards which a low index (0·5 or lower) or a high index (1·3 or higher) is recorded is usually regarded as the possible origin of infection and from this organism a vaccine is prepared. (K. W. Goadby suggests that if more than one organism show a low index a mixed vaccine of the several organisms should be obtained.) If two or more organisms are associated, as is frequently the case, a separate vaccine of each should be prepared, and if subsequent observations of the index towards each bacterium are recorded, the dosage of either vaccine may be modified as may be necessary. In all cases, and particularly if improvement is slow, further bacteriological examination of the case should be made from time to time.

The vaccines are prepared in doses of varying strength, each dose being placed in a small sterile glass bulb. The dose depends upon the responsible organism. For the most commonly encountered infecting micro-organisms Eyre recommends doses as follows:

	Millions.				
Micrococcus catarrhalis if apparently the sole infecting organism	5	10	25	50	
M. catarrhalis associated with streptococcus ...	10	25	50	75	100
M. paratetragenus	10	25	50	—	
M. pyogenes aureus...	50	100	250	500	
Streptococcus lanceolatus pneumoniæ (with which *Streptobacillus malæ* (Goadby) is probably identical)...	5	10	25	50	
S. pyogenes longus	5	10	25	50	
Bacillus pneumoniæ (Friedlander)	5	10	50	100	
B. pyocyaneus	10	50	100	250	

The injection of the vaccine must be carried out under strictly aseptic precautions.

As to the value of vaccine therapy in periodontal disease there is extreme divergence of opinion. Vaccine therapy aims at assisting the tissues to defend themselves against the action of bacteria and their products. It is essential for success, therefore, that we should know the causative organisms of the disease which has to be treated. There is reason to believe that periodontal disease is not caused by any special organism, but if it is due to a specific organism, that organism has not yet been identified. In the treatment of periodontal disease vaccine therapy therefore fails to satisfy the most important requirement. It may be urged in favour of vaccine treatment that the infection in the

pockets is causing local injury, and that vaccines will check the injury by raising the resistance of the tissues in the neighbourhood of the tooth. The difficulty here lies in the fact that the infection is invariably mixed, and the vaccine therapist must needs prepare a vaccine of all the organisms found. The practice, however, is to use a vaccine of the predominant organism or perhaps of two of them, and, under these conditions, the treatment is necessarily incomplete. But, granting that vaccine treatment is occasionally successful, the pockets still remain, and no amount of vaccine treatment will remove them.

Apart, however, from any consideration which may be regarded as more or less theoretical, the question arises whether vaccines lead to good results in the treatment of periodontal disease. I have had personal experience of many cases of periodontal disease which were treated with vaccines, and in no single case was a cure effected and in only a few cases could I detect any improvement.

When vaccine treatment is carried out concurrently with local remedies and improvement results, it is extremely difficult adequately to assess the amount of improvement which should be ascribed to the local measures on the one hand and to the vaccines on the other. It is the general experience that the majority of cases treated with energetic local measures will show a rapid improvement.

In the treatment of the general condition arising from mouth infection vaccines may undoubtedly be extremely useful.

In papers advocating the treatment of periodontal disease by vaccines it is constantly claimed that a large percentage of the cases have been cured. Manifestly much depends upon the exact meaning placed by the practitioner on the word "cured," and reference to this point has already been made (see p. 566). Eyre and Payne[1] do not take the view there expressed, but class as "cured" all cases where "the affected teeth are firm so that mastication is painless and the mouth comfortable, no pus can be expressed from the sockets, the pains and other symptoms of ill-health have disappeared, and the patient feels 'quite well.'" In such cases the patients are, in my opinion, relieved only and not cured. The pockets remain and recurrence of trouble is only a matter of time.

The method of treatment to be adopted in a case of periodontal disease will depend upon the conditions present.

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[1] *Proc. Roy. Soc. Med.* (Odont. Sect.), vol. iii, p. 39.

(1) Cases Favourable for Treatment

A case may be regarded as favourable for treatment if the following conditions are found:—

(*a*) The pockets around the teeth are shallow.

(*b*) The arch is well developed, and the function of mastication is efficiently performed.

(*c*) There are indications of recuperative powers on the part of the patient.

(*d*) The patient is a nose-breather.

As the pockets, which are the real cause of the trouble cannot be removed, treatment resolves itself into a question of drainage. The more thoroughly the pockets are cleansed, the greater will be the chance of staying the progress of the disease. The teeth must be thoroughly scaled, and the patient instructed to carry out the following daily routine:—

(*a*) Pass silk between the teeth to free the spaces of débris.

(*b*) Squeeze the gums so as to expel as much material as possible from the pockets.

(*c*) Brush the teeth and gums thoroughly with a stiff brush.

(*d*) Irrigate each space with peroxide of hydrogen, as suggested on p. 568.

(*e*) Twice a week apply to the pockets a 2 per cent. solution of iodine in alcohol.

These simple measures, if faithfully carried out, will suffice to arrest the disease in favourable cases. I have tried raising the resistance of the tissues by means of vaccines and Bier's method of congestion, but I am not satisfied that these cases showed greater improvement than others where the treatment was limited to irrigation. Thorough cleanliness of the pockets is the keynote in treatment, and, if this is achieved, an arrest in the progress of the disease may be expected.

(2) Cases not Favourable for Treatment

Cases which are not favourable for treatment are those which show well-marked signs of rarefying osteitis with general and local conditions indicating that the tissues possess little recuperative power; also all cases of persistent mouth-breathing. It will be convenient to group these cases under two separate headings, viz:

(*a*) Cases unassociated with apparent symptoms; and

(*b*) Cases in which a causal relationship to other diseases has been established.

(a) Cases unassociated with apparent symptoms

As regards cases falling under this heading, there are certain points which must be kept clearly in mind in endeavouring to arrive at the right line of treatment. Although efficient irrigation may check the discharge from the tissues, and some advantage may be gained in an attempt to raise the resistance of the tissues by the aid of auto or hetero-inoculation, all such efforts will fail to stop the advance of the disease. Under these circumstances the question arises whether it is justifiable to continue a course of treatment which, at the best, can do no more than slow down the progress of the disease. My own view is that such a course of treatment cannot be justified for two reasons: (1) Because a potential source of infection remains which may become active at any moment, and (2) because the destruction of the alveolar process is proceeding and thus increasing the difficulty of providing artificial dentures which will be efficient and comfortable.

(b) Cases in which a causal relationship to other diseases has been established

In this class of case it is absolutely necessary that the dental sepsis should be completely removed. After reviewing the cases which have come under my notice during the last ten years and carefully considering the results of different methods of treatment, I am driven to the conclusion that the removal of the affected teeth at the earliest opportunity is the right course to adopt, and that any other line of treatment will prove to be unsatisfactory. A typical example of this class of case is as follows: A young adult is suffering from rheumatoid arthritis and the mouth shows signs of general periodontal disease accompanied by rarefying osteitis in a marked degree. The case is one in which the potential source of trouble—that is, the pockets—cannot be removed by treatment. The choice here lies between retaining the teeth and running serious risk of an aggravated arthritic condition on the one hand, or, on the other hand, removing the teeth and ensuring useful joints. In my opinion, the latter course alone can be justified, as artificial dentures can be provided, but not new movable joints.

In carrying out extraction in these cases the following course should be adopted: The mouth is made as healthy as possible by thorough irrigation of the pockets with hydrogen peroxide. The premolars and molars are next removed and the mouth is allowed to heal. Models of the mouth are then taken with the incisors in place and bites are obtained. The advantage of proceeding on these lines is that you avoid the difficulty which would be experienced in

gauging the correct height of the bite after the removal of the front teeth. The anterior teeth are then removed and dentures inserted as soon as possible. The number of teeth which can safely be removed at one sitting depends largely upon the individual case. Where the "power of repair" is at a low ebb the extractions must be carried out by easy stages, but where there is ample "power of repair" the extractions may be carried out more expeditiously. I incline to the view that extensive extractions at one sitting should be avoided unless there are special reasons for adopting that course. It is said that trouble in the bone is likely to follow extensive extractions in these cases unless the resistance of the tissues is first raised by a course of vaccine treatment, but that is not my experi-

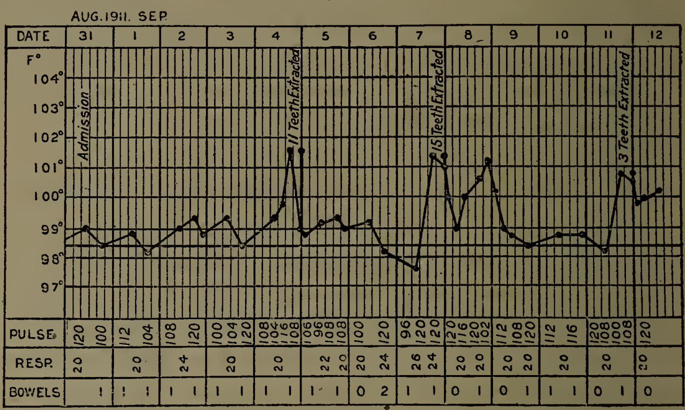

Fig. 730a.

ence. I am disposed to think that, where trouble in the bone occurs as a result of extractions, it is almost always due to the damage inflicted on the tissues by the operation. A rise in temperature seldom follows the extractions if the mouth is kept clean. Occasionally a rise in temperature does occur, as is well shown in fig. 730a. The patient was suffering from a corneal ulcer, and the removal of each batch of teeth was followed by a rise in temperature.

In cases where general trouble is traceable to the mouth it has been my practice to retain the anterior teeth provided that the bone destruction is slight. The argument in favour of retaining the teeth in these cases is that the pockets around the anterior teeth are easily accessible and can be thoroughly irrigated by the patient.

Experience of these cases has taught me, however, that if the patients are mouth-breathers it is only a matter of time before extraction becomes imperative. It would therefore seem sounder treatment to remove all the teeth and make certain that the patient is free from dental sepsis.

I am well aware that treatment by free extraction of all teeth which are the source of sepsis, as suggested above, is opposed to the teachings of many practitioners. With those who hold that local treatment will often result in a removal, or at least an improvement in the general condition, I fully agree, but—and this is the important fact—the source of sepsis has not been eradicated. The sepsis may possibly be lessened in degree, but nevertheless it remains and must continue to damage the tissues slowly but surely. The damage to the tissues is progressive, and when, through the loss of the teeth, a natural cure of the teeth is effected, the damage of the tissues may be irreparable. Dental practitioners cannot be justified in allowing such a condition to be brought about, and it is our duty to place clearly before the patients the risks they run.

Before leaving the question of treatment, reference must be made to ionic medication in the treatment of periodontal disease. My colleague, Mr. Norman Bennett, of whose judgment I have a high opinion, adopts the following technique in treatment. The teeth are freed of calculus and the mouth rendered as healthy as possible. It is not necessary—in many cases it is not possible—to remove all calculus as a preliminary to treatment; the process can be more completely accomplished during the course of treatment; indeed, small areas of marginal gingivitis which do not respond will often be found to be covering a small deposit of undiscovered calculus. A 5 per cent. aqueous solution of zinc chloride is generally employed, but salts of copper—such as the sulphate—or of silver, may be used. A few contiguous teeth should be isolated and kept moderately dry by means of napkins, wool rolls, or bibulous paper. Absolute dryness is not necessary, but too much moisture will not only dilute the drug unduly, but also allow the current to pass superficially instead of through the tissues. The current having been turned on and the rheostat control advanced a short distance, the electrode, previously wrapped round with a small quantity of cotton-wool, should be dipped in the solution and applied to the gum at least a quarter of an inch from the neck of the tooth; it should then be slid carefully over the gum until the neck of the tooth is reached and passed down into the pocket round the tooth. The most important parts are the approximal pockets. It is usually convenient to treat about half a dozen teeth at a time, dealing first with the labial or buccal aspects and the approximal pockets, and completing on the lingual aspects. The amount of current registered with any given voltage varies inversely with the resistance of the body. This resistance itself varies with different patients and with the same person at different times. The amount of current that can be tolerated is usually from one to five milliamperes. It will usually be found that

a current of one milliampere is not felt at all; more than five cannot usually be borne, except perhaps in the molar region. A current of three milliamperes is usually sufficient for therapeutic effect, and tolerable to the patient.

A current of low electro-motive force having been tried at the outset, it can be gradually raised by moving the rheostat control until sufficient is obtained. It should be remembered that most pain will be felt when the needle is first applied (the "make" of the current), less when it is broken, and least of all during the passage of the current, so long as the electrode is stationary. That is why the needle should, every time it has been dipped in the solution, be first applied to the gums and then moved to the tooth. If a large drop of liquid is hanging on the needle a considerable amount of pain may be felt at the first contact. Care should be taken to move the needle smoothly from one tooth to the next without making contact or even altering the area of contact more than necessary, because the current is felt more severely when passed through a small area than a large. When the teeth are very sensitive it is sometimes necessary to apply the needle first and then gradually turn the current on from zero; in this way pain may be minimized.

By taking groups of teeth in succession the whole mouth may be treated in about three-quarters of an hour, but it is often desirable to spend the greater part of the time over the most seriously affected teeth, three or four minutes being devoted to a single tooth. The only visible sign noticeable is a slight whitening of the edge of the gum, and a kind of white deposit spreading from the edge. It is only very rarely that any sensation is felt in the hand of the patient holding the negative electrode. It is desirable, however, that rings should be removed.

The application should be repeated every second or third day for a fortnight, then less frequently until about ten or a dozen applications extending over five or six weeks have been made. In this period it will be possible to judge results, and if considerable improvement cannot be obtained in that time or even less, it is not likely to be gained at all.

The action of ionization is probably to stimulate the soft tissues around the teeth and sterilize the contents of the pockets, the drug exercising an astringent action. It is questionable whether it possesses advantages over the local treatment recommended on p. 567. One constantly hears that the patient has undergone ionic treatment and is cured, but on inquiry no regular treatment is being carried out. In these patients the "pockets" around the teeth still exist, and if not regularly cleansed the disease must progress.

CHAPTER XIX

Diseases of the Gums and Adjacent Mucous Membrane

Hypertrophy of the Gums—Gingivitis—Stomatitis—Leucoplakia—Pemphigus—Purpura—Scurvy—Perforating Ulcer—Tubercle—Syphilitic Lesions—Aneurism

(A) HYPERTROPHY OF THE GUMS

True hypertrophy of the gums consists in a general overgrowth of that portion of the gums which covers the alveolar process. Good examples of this disease are represented in figs. 731 to 734, which delineate the mouths of two brothers aged 7 and 9, respectively, who came under observation in 1892. In a younger brother seen five years later at the age of six a similar condition was found, the thickening, according to the father's statement, having begun as the teeth erupted. The hypertrophied gum in all three cases was normal in colour, of a dense fibrous character, and was more marked in the front of the mouth. The mouths were clean and there was no tendency to bleed and no discharge. The boys were intelligent and there were no lesions elsewhere. The two parents and the two sisters were free from any abnormality of the gums.

The hypertrophy of the gums would seem to start with the eruption of the teeth. In a case quoted by Erichsen, the affection showed itself at the age of seven months, during the eruption of the incisors, and in another case, quoted by Heath, the swelling of the gums commenced at two years of age with the eruption of the deciduous molars. If left untreated, the hypertrophy increases, and in time the teeth become completely hidden.

The hypertrophy may be limited to a particular region; for example, in a case recorded by A. Evans[1] the trouble was confined to the molar region.

A **microscopical examination** made by C. S. Tomes of one of Heath's cases, showed that "the growth closely resembled that of the small polypi which are sometimes found occupying the cavity of the carious teeth; it was true hypertrophy of the gum, and chiefly

[1] *Proc. Roy. Soc. Med.* (Odonto. Sect.), vol. i, p. 125.

of the fibrous portion. It sprang from the periosteum round the neck of the tooth just within the margin of the alveoli. From this point emanated a dense stroma of interlacing fibres, covered by a thin mucous and epithelial layer."

In many of the accounts given of the disease, the gums are described as being darker than the normal, and as bleeding freely

FIG. 731.—F. S., aged nine years (maxilla).

FIG. 732.—F. S., aged nine years (mandible).

at the lightest touch. This condition of the gums is due to inflammatory reaction in the hypertrophied tissue from sepsis in the spaces between the teeth and gums.

The combination of hypertrophy of the gums with superadded inflammatory reaction may give rise to a most distressing condition of which the following case, recorded by Heath,[1] is a good

[1] *Lancet*, 1897.

example. The patient was a man, aged 26, and, four years before being seen, he had consulted a surgeon, who cut away the hypertrophied gums of both jaws and afforded considerable relief to the patient. Three months later, the growth had recommenced, and, although it had made steady progress for three years, the patient sought no further advice. On admission to hospital, the external

FIG. 733.—T. S., aged seven years (maxilla).

FIG. 734.—T. S., aged seven years (mandible).

deformity was well marked, and, on opening the mouth, the gums of both jaws were seen to be enormously hypertrophied, most of the teeth being loose and displaced (fig. 735). The palate at a cursory glance had the appearance of a cleft palate, but this was due to the fact that the hypertrophied gum on either side covered the palate almost to the median line.

A microscopical examination of the hypertrophied tissue showed

that the mucous membrane covering the growth was healthy, the bulk of it being composed of delicate bundles of wavy fibrous tissue which interlaced. Between the bundles were numerous cells, in some places forming large clusters. Numerous vessels were scattered through the growth.

The case recorded by Evans already referred to is interesting as an example of the degenerative changes that may take place in the redundant tissue. The tissue removed at the first operation consisted of "translucent strands of fibrous tissue," while that removed four years later was "composed of adult fibrous tissue arranged in strands, between which was some badly staining homogeneous material denoting some myxomatous degeneration; in places were

Fig. 735.

some thickened arterioles, and around these some round-celled infiltration; the overlying mucosa was slightly thickened, and beneath the thickened papillæ was some excess of round cells of inflammatory origin. The growth therefore was a fibroma undergoing early myxomatous degeneration, while the growth first removed was a pure fibroma and showed no degeneration."

A case exhibiting another clinical variety of hypertrophy of the gums is shown in fig. 736. This patient, a man aged 43, was under the care of Montagu Hopson. He subsequently developed a sarcoma in connection with the orbital plate of the maxilla. Two of his children also showed slight hypertrophy of the gums.

Hypertrophy of the gums is at times correlated with abnormalities of other tissues. In three cases recorded by Murray[1] which

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[1] *Med. Chir. Trans.*, vol. lvi.

occurred in three children (two girls and a boy), the condition was associated with molluscum fibrosum and defective mentality.

In the well-known case of Julia Pastrana, hypertrophy of the alveolar process and overlying soft tissues was accompanied by excessive development of the hair. A similar condition existed in an Indian girl, Kras, aged seven years, mentioned by Parreidt.[1] The hypertrophied gums were accompanied by a well-developed growth of hair on the body.

Treatment.—Microscopical sections demonstrate that the hypertrophied gum springs from the alveolar margin. In treatment, therefore, the affected alveolar process must be removed with the excess of gum, as the trouble is likely to recur if the gum only is removed.

FIG. 736.[2]

(B) REACTION OF THE GUMS AND ADJACENT MUCOUS MEMBRANE TO INJURY—INFLAMMATION.

A general inflammation of the mucous tissue of the mouth is called "stomatitis," but when the inflammation is limited to the gums it is usually termed "gingivitis."

(1) GINGIVITIS.

This condition may be general, or may be limited to the gum margin—"*marginal gingivitis.*"

(a) Marginal gingivitis is a common affection, and, if not treated, leads to chronic periodontitis.

Pathology.—In a mouth that is functional, the constant friction of efficient mastication and the friction of the mucous membrane

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[1] *Deutsche Monatsschrift für Zahnheilkunde*, 1886, Jahrgang iv, H. 2.
[2] From *Trans. Odonto. Soc.*

of the cheeks and lips against the gum margins, assisted no doubt by the free flow of "currents of saliva," remove all débris, and keep the gingival margins in a healthy condition. Abnormal conditions, such as mouth-breathing, and fuctionless teeth, lead to the accumulation of food débris, &c., at the gingival margin; the material thus lodged undergoes fermentative and putrefactive changes, the soft tissue is injured, and inflammatory reaction follows. Such a condition is well marked in mouth-breathers. If the mouth of a child suffering from nasal obstruction be examined, a marginal gingivitis will be found around the anterior maxillary and mandibular teeth, while the gingival margin at the posterior part of the mouth will be found quite healthy, providing that the function of mastication is properly performed. In a mouth-breather, the natural friction of the lips against the gums is, to a great extent, in abeyance, with the result that the débris around the teeth is not removed and a

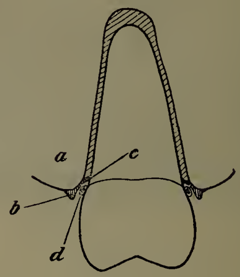

FIG. 737.—(*a*) alveolar process; (*b*) free margin of gum; (*c*) dental ligament; (*d*) calculus.

condition arises which causes injury to the gingival margin. The gingivitis so often associated with many fevers arises, partly at least, from a similar cause. The fevers frequently bring about a condition which induces mouth-breathing and, a "slop" diet being necessary, the ordinary functions of the mouth are not performed, and food naturally collects at the gingival margins.

Although gingivitis is generally the direct result of lodgment of food débris, &c., it may also arise from toxic material circulating in the blood. In reference to this G. V. Black remarks that the gingival organ, in common with other glandular structures, seems to possess the function of selecting and eliminating from the blood certain poisons, as evinced in mercurial gingivitis. The elimination of the poisons or toxins leads to hyperæmia or inflammation. As a result of hyperæmia, or chronic inflammation, a dark-coloured calculus forms under the free margin of the gums (fig. 737). It is

not yet known precisely how this calculus is formed. It may be a product solely of the inflammatory condition of the gingival tissues, or a union between the calcium salts of the saliva and the inflammatory exudation. The calculus when formed acts as a local irritant and increases the morbid condition. In certain conditions the calculus does not form.

Varieties.—The inflammation is usually catarrhal in character. It *may become purulent,* while in certain patients there is a tendency to hypertrophy; large tags of tissue are formed between the interspaces of the teeth, and the gum encroaches upon the surface of the teeth so that the teeth are partly hidden. This form is usually designated "*chronic hypertrophic gingivitis*" (fig. 738). The so-

Fig. 738.

called "polypus of the gum" is a localized "chronic hypertrophic gingivitis."

Causes.—(i) *Local.*—Mechanical irritants, such as the accumulation of calculus and food débris at the necks of the teeth; overhanging edges of fillings and badly adjusted crowns; the injudicious use of clamps, ligatures, &c., and chemical irritants.

(ii) *General.*—The prolonged administration of mercury, lead and iodides. Marginal gingivitis is a frequent accompaniment of certain general diseases, such as diabetes, nephritis.

Signs and Symptoms.—The free margins of the gums are red and painful and bleed freely with the lightest touch. Slight pressure will cause a thick creamy discharge to exude around the necks of the teeth.

Treatment.—The treatment of gingivitis is to remove the cause

if possible. When mouth-breathing is the cause, prompt attention must be directed to the relief of the nasal obstruction, while, if the disease is due to a general cause, general treatment must be adopted. Locally, attention must be paid to the hygiene of the mouth and special care taken to free the spaces between the teeth from all foreign matter. The pockets around the teeth may be syringed with hydrogen peroxide and an astringent mouth-wash prescribed. In marked cases, the application of powdered tannic acid to the gums twice a day will also prove a useful remedy. Where there is considerable discomfort amounting at times to pain, the application of a lotion composed of equal parts of tincture of iodine and spirits of camphor will be found beneficial. Where the inflammation is of a proliferative character, it is advisable, in addition to the above treatment, to cut off with a small pair of curved scissors the tags of gum which are present in the interstices of the teeth, and freely scarify the other portion of the gum.

An acute attack of gingivitis may arise from direct infection, for example, the gonococcus. Under these conditions, the infection rapidly spreads to the periodontal membrane, the teeth becoming loose and bathed in pus. There is marked salivation and a rise of temperature. The treatment that answers well is thorough irrigation of the tooth sockets with hydrogen peroxide and the application of nitrate of silver, 10 gr. to the ounce, twice daily.

Lead Poisoning in Relation to the Gum Margins.—In chronic lead poisoning a blue or slate-coloured line often appears on the gums. The manner in which the line is formed is not quite clear. It is supposed that the lead brought by the blood to the gingival margin is converted into a sulphide. The line is more frequently seen on the lower gums than on the upper, and in the incisor region more than in the molar. In addition to the blue line, lead poisoning usually presents other symptoms, such as colic and wrist-drop, the latter being due to paralysis of the extensor muscles of the wrist. In rare cases the blue line is present, but no other symptoms; in such cases great care must be taken to eliminate all other possible causes. In individuals who take diachylon to produce abortion the characteristic blue line on the gum is frequently present.

The blue line must be diagnosed from (i) a delicate line of blue at the margin of the gums and teeth but not involving the gums, which occurs in persons exposed to white lead dust for a few hours. This line is merely lead sulphide deposited upon the gums and disappears on rinsing the mouth.

(ii) A deposit under the margin of the gums, which is found in persons who clean their teeth with charcoal.

(iii) A deposit similar to (ii), occurring in miners and others exposed to carbon dust.

(iv) The line caused by copper and bismuth poisoning.

It must be noted that the blue line does not appear if the teeth are missing, and that it is most prominent when a source of irritation, as, for instance, "tartar," exists around the necks of the teeth.

Treatment consists in removing the patients from the unhealthy surroundings, when the line will generally disappear in three or four weeks, although in severe cases the line may persist for a much longer period.

(b) Chronic gingivitis is usually the result of local irritation. It is frequently seen in patients wearing artificial dentures, and is often due to want of cleanliness. The gums are slightly swollen and are red, congested and painful. A temporary relinquishment of the denture and the use of astringent mouth-washes is sufficient to effect a cure. Any general condition will need treatment.

Artificial dentures in certain subjects, more especially those of a gouty or rheumatic diathesis, produce a peculiar tenderness of the gums, accompanied by an itching sensation, the patients stating that they can only get relief by removal of the dentures. Local applications are of little value, and the removal of the denture, except, of course, at meals, seems to be the only means of obtaining relief.

A rare form of chronic inflammation of the gums has been described by Arkovy[1] under the name of "*gingivitis nudata*." The disease usually has its seat in the roof of the mouth and spreads until it involves the interdental papillæ, or it may be limited to the latter. It appears at all stages of life and may continue for one or two years. With the naked eye it is difficult to locate the junction of the affected with the non-affected part, as the edges are not pronounced and the colour of the gums is unaltered. *The pathology of the condition* is an entire absence of the epithelial covering of the sub-mucous tissue, leaving the papillæ exposed.

The etiology is obscure : occasionally it may be traced to scalding. Dentures with rough surfaces, or which do not fit accurately, may contribute to the production of the disease. The symptoms are a feeling of "continual burning with sensitiveness of touch, especially during meal-times."

Treatment should aim at restoring a layer of epithelium over the denuded sub-mucous tissue. All irritants, whether in the form of foods or otherwise, should be avoided. The foods taken must be

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[1] *Dental Cosmos*, October, 1893.

of a mucilaginous and slippery character, and all medicaments must be administered in a similar condition.

Ulcerative gingivitis — Vincent's angina. — This condition is seldom found in mouths where the gingivæ are normal. The ulceration usually starts around badly fitting crowns, in the deep pocket posterior to the lower third molar, and in mouth-breathers, around the necks of the lower incisors, but it may commence in any position where there is periodontal disease—in other words, in pre-existing stagnation areas. Within from twenty-four to forty-eight hours the infection spreads rapidly along the gingival margin, involving both jaws, and often extends backwards to the pillars of the fauces, to the hard palate, and the floor of the mouth. The gums bleed readily and present a ragged margin of necrotic tissue; the periodontal membrane is rapidly involved, and the margin of the

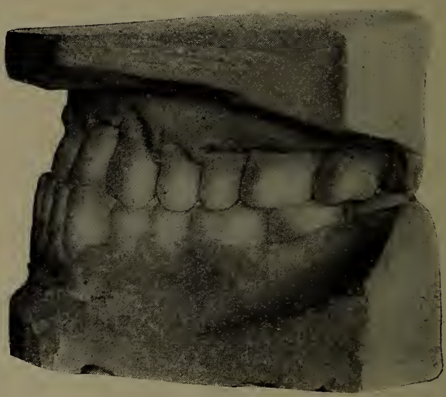

Fig. 739.[1]

bone becomes exposed (fig. 739). With the gum condition are usually associated lesions of the mucous surfaces of the fauces, tonsils, soft palate and pharynx, which become covered with patches of exudation forming a yellowish to greenish-yellow membrane and these may remain superficial or tend to spread into the deep layers of the tissues. The breath has a most offensive odour, and pus and blood well up around the teeth. If left untreated, the teeth rapidly loosen and are lost, and the adjacent tissues are deeply ulcerated and the lymphatic glands enlarged. The local condition is attended by a rise in temperature varying from 100° to 103° F., which usually falls to normal about the fourth or fifth day.

Taylor and McKinstry[2] are of the opinion that the primary lesion

[1] From *Dental Cosmos*.

[2] *Brit. Med. Journ.*, March 31, 1917.

is in the gums, and that the throat and pharynx are infected from the gums.

There is every reason to believe that the disease is communicable and it has been very prevalent among the troops during the present war.

The symptoms and general course of the disease are similar to those characterizing the condition usually known as Vincent's angina; "indeed, it is probable that they are one and the same affection, the main focus of the disease lying in the gingivæ." Two varieties of Vincent's angina are recognized: a mild or diphtheroid type, in which the process is limited in extent of surface and does not penetrate to any depth; and a severe or ulcero-membranous type, in which the process extends rapidly over the surface and involves the mucous membrane deeply.

Bacteriological examination shows that, in addition to pyogenic cocci, a characteristic bacillus (*B. fusiformis*) is present in the exudation frequently associated with a spirillum. In the mild type, the bacillus predominates; in the severe type, the spirillum is "much more frequent and may even be present in greater numbers than the bacillus." The bacillus described by Vincent is called the "fusiform bacillus."

Treatment consists in thorough irrigation of the pockets around the teeth, and also of the affected mucous membrane, with hydrogen peroxide, followed by the application of strong *tincture of iodine*. The acute symptoms rapidly improve under this course of treatment, but a chronic condition often remains which requires careful hygienic treatment on the part of the patient. Teeth which are obviously the source of chronic sepsis should be removed, and, in cases where the stomatitis spreads from the misplaced third molars, these teeth should be removed.[1]

The local application of ipecacuanha and arsenic is strongly recommended by some authors.[2]

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[1] In connection with this question, the following papers will be found worthy of perusal: "On Vincent's Angina," H. W. Bruce, *Lancet*, July 16, 1904, p. 135. "Cases of stomatitis and tonsillitis in which Vincent's spirochæte and bacillus were present," W. H. Harwood-Yarred and P. N. Panton, *Lancet*, February, 1906, p. 438. "The Relation of Periodontal Gingivitis to Vincent's Angina," F. E. Taylor and W. H. McKinstry, *Brit. Med. Journ.*, March 31, 1917. "Ulcero-membranous Stomatitis and Gingivitis among Troops on Active Service," F. B. Bowman, *Brit. Med. Journ.*, March 11, 1916. "Ulcerative Gingivo-stomatitis due to Vincent's Bacteria," H. S. Vaughan, *Dental Cosmos*, June, 1912.

[2] ℞ Vin. ipecacuanhæ ... ℥ss
Glycerini ... ... ʒj
Liq. arsenicalis... ... ad ℥j

It is most important that mouth-breathing, if present, should be corrected; as long as it is present the condition is extremely difficult to control.

In intractable cases the local application of salvarsan has been recommended, the drug being applied to the pocket on a swab moistened with glycerine.

(c) Polypus of the gum.—Polypus of the gum is the name given to a local hypertrophy of that tissue caused by irritation.

Causes.—This condition is generally found in connection with the ragged edge of a cavity or root, or may be brought about by the presence of calculus, or even irritation from a clasp or some other portion of an artificial denture.

Appearances.—In character and microscopical appearance a polypus resembles the gum tissue. The growth really starts as a simple hypertrophy of the gum; this increases and becomes pedunculated, and, if the cause is not removed, may become so enlarged as to simulate a fibrous tumour.

A polypus of the gum may, as it grows, encroach upon the cavity and eventually completely fill it. Should the hypertrophied tissue come in contact with the opposing teeth, ulceration will ensue and give rise to considerable pain.

Diagnosis.—When the polypus occupies the cavity, care must be taken to diagnose it from a polypus of the pulp. The diagnosis is not difficult, as in one case the pedicle of the growth will be in connection with the pulp chamber, while in the other it can be traced to the gum between the teeth. The polypus of the pulp is not painful to the touch, whereas polypus of the gum is extremely painful to pressure.

The treatment consists in removing the source of irritation, but, in addition, it is generally advisable to snip off the growth, or, if the growth is in connection with a cavity, it is better to remove the growth with some potassa cum calce, or with the actual or electrical cautery. The cervical margin of the cavity must be carefully trimmed, so as to avoid any overlapping edges which might assist the accumulation of food débris, &c., and so provide a source of irritation.

(2) STOMATITIS

(a) Catarrhal Stomatitis.—This form is generally associated with inflammation of the throat or nose, and probably arises from the same cause as catarrh of those parts. It is frequently seen in the course of the exanthematous fevers and gastro-intestinal disturbances. The excessive use of tobacco, or too hot or too highly seasoned foods, may be cited as causes.

Signs and Symptoms.—The serum from the congested mucous membrane filters into the sub-epithelial space. There is an increased production of surface epithelium and also of mucus. This mucus continues and, with the serum, forms the peculiar sticky discharge seen in these cases. In more severe cases the epithelium may be detached in large masses, the sub-mucous tissue becomes greatly infiltrated with leucocytes and the whole mucosa swollen, giving rise to a purulent or muco-purulent condition. The margins of the gums become acutely inflamed and painful to the slightest touch. In the early stages the gums are dry, but this is soon followed by an excessive secretion. The portion of gum attached to the margin of the alveolar process is pale, while the reflection of the gum from this point on to the cheek will show the vessels to be congested. The gums appear whitish and mottled, and pus is generally seen welling up from the sulci around the teeth.

The mottled appearance of the gums is due to the fact that in inflammation the epithelium proliferates and appears whitish, but through the friction which occurs between the gums and the cheeks the epithelium covering the papillæ of the gum is rubbed off and leaves reddish patches here and there. The breath is fœtid, the patient has a sensation of heat and pain and the taste is impaired. The tongue is furred, there is a loss of appetite, derangement of the bowels, and a feeling of malaise.

Treatment.—The cause should, if possible, be removed, antiseptic and astringent mouth-washes should be used and the general condition of the patient treated by appropriate remedies.

(b) Mercurial Stomatitis.—Prolonged use of mercury is likely to lead to gingivitis which rapidly spreads to contiguous parts. The ptyalism, so often seen in cases of mercurial stomatitis, is due to the spread of inflammation to the salivary glands. The early symptoms are soreness and discomfort in the mouth, accompanied by a metallic taste and fœtid breath. The gums become inflamed, and present a deeply congested appearance at the free edges; the portion attached to the margin of the alveolar process remains whitish, and the portion beneath presents the whitish mottled appearance referred to above. The teeth become loose, sloughing and ulceration occur near the margin of the gum; the slough separates and the teeth fall out. The inflammation spreads rapidly to the cheeks, tongue, floor of the mouth, and to the salivary glands, leading to a profuse flow of saliva. There is much pain in swallowing, speaking, and on moving the jaws. In severe cases, if not quickly treated, extensive sloughing and necrosis may supervene.

With regard to the pathogenesis of mercurial stomatitis,

Alonkvist,[1] who examined specimens from subjects who had died in the course of mercurial treatment, concludes: "That the deposition of mercurial granules takes place in the vessel walls, and in preference in the capillary loops nearest to the epithelium. During the evolution of the disease the following phenomena occur in the gum and mucous membrane. Deposition of granules of mercuric sulphide, vascular dilatation, diapedesis of leucocytes laden with the mercury granules, degeneration and death of the histological elements of the tissue. The mercury is deposited through the action of hydrogen sulphide formed during the decomposition of proteid matter in the mouth or intestinal tract. The latter compound precipitates the mercury which circulates through the blood-vessels and that which is eliminated through the oral mucous membrane in the form of mercuric sulphide. Hence the necessity of keeping the mouth and teeth in a perfect state of cleanliness during mercurial treatment, and of paying as much attention as possible to the digestive functions, in order to avoid the formation of excessive amounts of hydrogen sulphide. Inflamed gums caused by carious teeth do not hug the teeth tightly at the neck, and in the interstices thus produced food débris accumulates, and, in undergoing decomposition, hydrogen sulphide is formed, which causes the precipitation of the mercury eliminated through the mucous membrane."

"In animals mercurial intoxication is not as a rule accompanied by stomatitis, which, however, may be induced by detaching the gums around the teeth and irrigating the pockets for some time with solutions of hydrogen sulphide."

Treatment.—Local.—In mild cases, the use of an antiseptic mouth-wash is sufficient. In severe cases, local depletion will be found advantageous.

General.—The administration of the drug must be stopped, and the bowels made to act freely by means of saline purgatives. A plentiful use of alkaline mineral water should be enjoined. The diet should be in a liquid form, and, if there is much pain, opium in the form of pulv. opii co. may be given at night. The general anæmic and debilitated condition which follows severe "ptyalism" requires a supporting form of treatment.

The internal administration of bismuth and the application of bismuth paste to wounds is at times followed by severe stomatitis which simulates in its clinical features mercurial stomatitis.[2]

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[1] See "Mercurial Stomatitis: Present Status of the Question," Raymond Lulle, *Le Progres Dentaire*, September, 1907.

[2] Papers for reference: "Systemic Poisoning with Bismuth," W. H. Higgins, *Journ. Amer. Med. Assoc.*, Feb. 26, 1916; "Bismuth Poisoning," L. Mayer and G. Baehr, *Internat. Journ. Surg., Gynæcol. and Obstet.*, vol. xv, p. 309.

(c) Ulcerative Stomatitis.—This condition is most frequently met with in children. It may prevail in an epidemic form in institutions where insanitary conditions exist. Want of cleanliness, faulty hygienic surroundings, and general ill-health favour the development of the disease.

The inflammation commences at the free margin of the gums, and is said to be more frequent in the maxilla. In the early stages the gums are swollen and congested, the congested veins leading to the part being distinctly visible. The ulceration, commencing at the free margin, gradually spreads, denuding in its course the alveolar process, and leading to necrosis of the teeth. The adjacent mucous surface of the cheek usually becomes attacked from contact, and, if the case is left alone, the ulceration may extend, leading to extensive necrosis, sloughing, and, ultimately, death of the patient. In well-developed cases, an ulcer with sharp irregular edges is seen, the margin displaying a bluish ring, the ulcer being covered with a greyish or yellowish slough, the neighbouring lymphatic glands being enlarged.

Bacteriology.— In this disease, the *Bacillus fusiformis* and *Spirochæta dentium* are always present in great numbers; and observers who have examined such cases have generally come to the conclusion that the fusiform bacillus and the spirochæte are the causative organisms.

By epidemiologists the disease is often thought to be related to the foot-and-mouth disease of cattle (see p. 598), and in this disease no definite micro-organism has been isolated; but whatever the organism may be, it is apparently somewhat smaller than any organism we are acquainted with as yet, as the living virus will readily pass through the pores of a Pasteur and Chamberland filter.

Guezette[1] considers that ulcerative stomatitis is closely related to noma. The most constant feature in three cases he examined was the presence of a spirillum and a bacillus. He injected the discharge from a case upon his own lip, and found that the spirillum speedily disappeared whilst the associated streptococcus flourished freely.

In addition to the spirochæte and *Bacillus fusiformis*, in three cases of ulcerative stomatitis which Goadby examined he found the *Saccharomyces albicans* present in large numbers, both on the films direct and upon cultivation. The organism takes some little time to develop, and may easily be missed. It is quite possible that this organism may be only a concomitant to the inflammatory

[1] *Archiv. de la Sci. Méd.*, vol. xxiii, No. 1.

condition, but it is not common in ulcerative lesions of the mouth, whereas the *Bacillus fusiformis* and the spirillum occur whenever any diseased condition of an inflammatory nature is present in the mouth.

Signs and Symptoms.—In the early stages there is little pain, and the disease may be far advanced before it is discovered by the parents, and then the odour of the breath is the first symptom noticed. Constitutional symptoms are marked in severe cases, and death sometimes results.

Treatment. — Treatment consists in administering internally chlorate of potash, a drug which seems to be a specific for this disease. Children should be given 5 to 10 gr. according to age, adults 15 to 20 gr. It is well to give at the same time some iron or such-like tonic in the following form :—

℞	Liquoris ferri perchloridi	♏ii
	Potassæ chloratis	gr. v to x
	Aquam aurantii	ad ℥i

Misce. Mitte ℥ii.

(One teaspoonful to be taken three times a day after meals.)

A mild purgative should be given, and an endeavour made to improve the surroundings of the patient, should these be at fault. Plenty of exercise in the fresh air should be recommended.

Locally, all unhealthy teeth should be removed, and the ulcer should be painted with a strong solution of nitrate of silver, the mouth being kept clean by frequent irrigation with hydrogen peroxide. Should the cheek be involved as well as the gums, a strip of lint moistened with carbolized oil should be placed between the two surfaces. A gargle of chlorate of potash should be prescribed,[1] and its frequent use recommended. Under this treatment most cases speedily improve.

A curious form of ulcerative stomatitis intimately connected with menstruation is recorded by Davis[2] under the name of *cyclical stomatitis*. The patient, who was a married woman, aged 35, had had four children. "Several times before the birth of the last child, attacks of stomatitis coincided with menstruation. For three years after this she suffered from severe ulcerative stomatitis, involving the tongue and the whole of the buccal mucous membrane. The first sign of the menses was soreness of the mouth, appearing five days before the menstrual flow. The attack was at

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[1] ℞	Potassæ chloratis	℥i
	Acidi hydrochlor. dil....	℥ss
	Aquam	ad Oi

Misce. To be used as a gargle.

[2] *Medical Times*, May, 1898

its height at the end of menstruation, at which time the mouth was full of small, dirty ulcers. During the stomatitis no solid food could be taken, and liquids only with caution. All medical treatment had failed, and as the patient was losing ground the tubes were removed. Both ovaries contained cysts about the size of a duck's egg, and the right Fallopian tube contained a mass of blood-clot which was not a tubal gestation. The patient completely recovered. As to the explanation of the cyclical character of the stomatitis, the author suggests that it may have been a feeble attempt at vicarious menstruation."

In women who are nursing, ulcers of the mouth are common. They usually occur on the lips and cheeks, arise from the mucous follicles, and vary from 3 to 5 mm. in diameter. As a rule, they cause no inconvenience and heal speedily with the application of nitrate of silver and attention to the general health.

(d) Gangrenous Stomatitis; Noma; Cancrum Oris.—This very serious disease is a rapidly spreading gangrenous inflammation which usually attacks the cheeks, and occurs in children from 2 to 6 years old. The disease may, however, occur in adults.[1] It is more common in girls than in boys. It is frequently seen in those just recovering from one of the exanthematous fevers. Unhygienic surroundings and weakening of the system by long-continued administration of mercury also act as predisposing causes. The disease may start either in the substance of the cheek, or in the mucous membrane, the latter being the more usual situation. The cheek becomes hard, brawny, and very swollen, a dark red colour showing in the centre, the surrounding parts being œdematous. At this stage, if the mouth be examined, an ulcer will be seen on the mucous surface of the cheek corresponding to the dark spot on the cheek. The ulceration, or rather sloughing, leads to perforation of the cheek, and, if the disease still pursues its course, the soft parts rapidly become gangrenous. The child becomes exhausted, delirious, and eventually dies of exhaustion, blood poisoning, or some septic affection of the lungs.

The facts that the whole cheek becomes gangrenous, and that the disease is not amenable to the action of chlorate of potash, help to distinguish it from ulcerative stomatitis, but most authors think that the difference between cancrum oris and ulcerative stomatitis is only one degree. The disease is said to be caused by thrombosis of the capillaries, induced by the presence of a

[1] See *Lancet*, December 21, 1901, p. 1730.

specific micro-organism, and is similar to the gangrenous inflammation known as noma, which occurs upon the female genitals.

The disease in rare instances may commence at the gingival margin. A case illustrating this point is recorded by C. Lockyer.[1] The patient, a youth aged 18, removed three roots of a tooth by means of a wooden penholder sharpened and used as an elevator. Four days subsequently the face began to swell, gangrene ensued

FIG. 740.—A case of gangrenous stomatitis. Museum of Charing Cross Hospital.

and spread rapidly over the palate and the alveolar process, the patient eventually succumbing to general septic infection (fig. 740).

Bacteriology.—Walsk[2] found in eight cases of noma the diphtheria bacillus. In one case the culture was pure; in the remaining seven it was associated with other bacteria. Four of the cases started as ulcerative stomatitis, but in fifteen cases of the latter

[1] "A Case of Gangrenous Stomatitis," *Brit. Dent. Journ.*, vol. xxix, p. 605.
[2] *Proc. Path. Soc. Philadelphia*, June, 1901.

condition the diphtheria bacillus could not be found. Hellsen[1] states that he has isolated from a case of cancrum oris a diplococcus which he was able to cultivate, and which when injected into an animal, caused the identical disease. From the latter source it was obtained in pure culture. Four generations of bacteria were obtained from the original growth, and each caused a well-defined case of necrosis in the specimens experimented upon. It is worthy of note in this connection that the *Diplococcus pneumoniæ*, an organism frequently present in suppurative conditions and infections of the mouth, when injected into guinea-pigs causes a fibrinous exudate, later breaking down at times into necrotic pus.

Professor von Babes, in Kollé and Wassermann's "Handbuch der pathogenen Micro-organismen," gives a number of references to spindle-forming and thread-forming organisms which have been described from time to time as associated with gangrenous stomatitis. The *Bacillus fusiformis* of Vincent and the *Spirochæta dentium* are supposed by some to be associated with this disease, and, some time since, Bernheim considered that the spirochæte was the cause of the disease, as it was usually present in large numbers. Other observers have thought that the *Bacillus necrosis*, or a streptobacillus of Zohr, was an organism which played a part in the production of gangrenous stomatitis. In one or two instances the bacillus of malignant œdema has been described, but as yet there is no settled bacteriology with regard to the disease. The disease is fortunately uncommon, at any rate in England; and there is little opportunity for making bacteriological examinations.

The *prognosis* of cancrum oris is bad. The *treatment* consists in carefully drying the soft parts, removing all gangrenous portions, and cauterizing the remaining surface with nitric acid, or the actual cautery. The general treatment should consist in supporting the patient's strength with a plentiful supply of beef-tea and other nutritious remedies. It has been suggested that free excision of the gangrenous surfaces would be an effective treatment, and in cases recorded it has proved beneficial. Corrosive sublimate locally applied has been used; it has proved successful in three cases recorded by Kingsford.[2] Disinfectant mouth-washes must be prescribed, and the raw surfaces carefully dressed with antiseptics. The disease may spread until the whole side of the face disappears, the cavity extending from the nose to the ear, and from the lips to the upper eyelid.

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[1] *Münchener med. Wochenschrift*, 1907, No. 5.
[2] *Lancet*, May 4, 1889.

(e) Follicular Stomatitis.—This inflammation is similar to an ordinary herpetic eruption. A cluster of vesicles first appears, which on breaking down coalesce and form a small circular and well-defined ulcer. This ulcer is surrounded by a zone of redness, and is extremely painful. The ulcers are said to occur more frequently near the frænum of the lip, on the under surface of the tongue, and in the sulcus between the gums and the lip. The little round punched-out ulcers met with in the cheeks are probably a variety of this form. Follicular stomatitis occurs in adults less frequently than in children. It is often associated with some gastro-intestinal disturbance.

The *treatment* consists in the application of an astringent solution, and, in intractable cases, the ulcers may be touched with a crystal of sulphate of copper or nitrate of silver. The general condition of the patient must also be treated.

(f) Parasitic Stomatitis.

(1) Due to Saccharomyces albicans (Thrush). — Thrush is a parasitic inflammation of the mucous membrane of the mouth, dependent upon a fungus, the *Saccharomyces albicans*. It is common in infants, but may occur in adults, and, in the latter, is generally associated either with some of the acute specific fevers, or with chronic wasting diseases, such as phthisis. When associated with phthisis it generally proves fatal. The fungus develops in the upper layers of the mucosa, the filaments forming a dense network among the epithelial cells. In this manner the mucous membrane becomes covered with numerous white spots, which are firmly adherent, and, when removed, a deep red colour is revealed. These spots appear mostly near the angles of the mouth and on the tongue, but may occur elsewhere in the oral cavity, the affection spreading at times to the pharynx and œsophagus. The spots are about the size of a pin's head, are circular in form, and they gradually coalesce and form larger patches, giving rise to the appearance of a false membrane with a slightly yellowish aspect. These patches come away of their own accord leaving a reddish surface beneath. The patches are found to consist of epithelium and fat, together with sporules of the *Oïdium albicans*, the vegetable parasite which causes the disease.

When thrush occurs in children they are generally found to be out of health, the bowels relaxed, the evacuations green and sour. The motions are generally acrid, and irritate the margins of the anus, giving rise to an erythematous blush over the buttock, the appearance of the edges of the anus being similar to that seen in the mouth. Sucking and deglutition are impaired by the condition

of the mouth, and the child will usually be in a state of drowsiness and torpor. Many cases of thrush in infants are distinctly traceable to the use of dirty feeding-bottles.

The *treatment* of thrush may be divided into local and general. The *local* treatment consists in carefully wiping the mouth with soft lint after each meal, care being taken to burn the lint after use. The exposed surfaces thus left are touched with a solution of 3 dr. of borax to 1 oz. of water. In severer cases, it will be advisable to use nitrate of silver, 5 gr. to the ounce, or dilute carbolic acid in glycerine. It is needless to say that attention should be given to the condition of the feeding-bottle. The *general* treatment should consist in careful attention to the diet, with the administration of a mild aperient.

(2) Due to the Aspergillus nigrescens.—An inflammatory condition due to the presence of the *Aspergillus nigrescens* has been reported.[1]

The following is a brief account of the case: "A small ulcer first appeared on the middle line of the roof of the mouth, about half-way between the incisors and the soft palate. The patch increased slowly in size, and others formed in the neighbourhood, the condition appearing like a lumpy patch extending from just behind the incisors to within one-fourth of an inch of the soft palate. Cup-shaped elevations on the soft palate appeared on either side of the middle line. A firmly attached membrane, giving rise to hæmorrhage when forcibly removed, covered the areas. The colour of the recent deposit suggested the sulphur-coloured scutula of favus; where it had remained undisturbed it was darker. With low power the growth was recognized under the microscope as a fungus differing from the achorion. The mycelium network was composed of delicate fibres, bearing perpendicular fructifying hyphæ. Scattered over the field were a number of fruit receptacles and a few spores. The manner of fructifying showed that the fungus did not belong to the oïdium, but to the ascomycetous genus. Cultures showed the *Aspergillus nigrescens*. Upon applying 25 per cent. ethereal solution of pyrozone, improvement was immediately noticed. The pseudo-membrane disappeared and new patches ceased forming. After seven weeks' treatment the patient was well."

"The spores were supposed to have been implanted in the mouth through the medium of cheese, strong and mouldy varieties of which the patient was very fond of eating."

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[1] *Medical Record*, October, 1896 (*Dental Digest*, p. 641, 1896).

(g) Aphthous Stomatitis.—This form rarely occurs in adults. It is characterized by the formation of fibrous deposits on and under the epithelium, and is considered by some authors to be contagious. It is frequently met with in rachitic and weakly children and is most common during the periods of dentition. In adults it occurs in those debilitated by illness, or may be associated with general inflammatory conditions. In women, it occurs during menstruation, pregnancy, and during the puerperal period.

Bacteriology.—Of ten cases of aphthous stomatitis examined by K. W. Goadby a streptococcus was present in six having the characters of the *Streptococcus fæcalis*, and not of the ordinary *Streptococcus brevis* of the mouth.

Signs and Symptoms.—Small yellowish-white patches, slightly elevated and extremely sensitive, are present on the mucous membrane. The patches are surrounded by a zone of inflammation. They have a tendency to spread and coalesce, forming large patches. When not associated with any active general disease, constitutional symptoms may be present, namely, slight elevation of temperature, thirst and loss of appetite.

Treatment.—Locally, a mouth-wash of chlorate of potash should be used, and the mouth thoroughly cleansed after each meal. If the aphthæ persist, they may be treated with nitrate of silver. The constitutional condition also requires attention.

In cattle *aphthous stomatitis appears in an epidemic form* and is commonly known as "*foot-and-mouth disease.*" It is communicable to man. In man it is an eruptive fever running a fixed and definite course, usually in eight to ten days, and is characterized by a vesicular eruption in the mouth, on the lips, gums and tongue, as well as on the hands and feet. In the early stages of the disease there is a headache and loss of appetite, with a quickly rising fever. Pustules appear in the mucous membranes of the mouth, more frequently on the lips and the tongue than on the hard palate and the throat. After a few days the pustules burst, leaving eroded spaces with greyish-yellow surface, which during the second week commence to heal. In the acute stage, the patient suffers from a sensation of heat and burning in the mouth, the cervical and salivary glands swell, producing severe dysphagia.

(h) Chronic Neurotic Stomatitis. — This condition appears usually in patients suffering from mental worry. It is an uncommon condition. Knowsley Sibley[1] considers that it is not of

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[1] *Brit. Med. Journ.*, April 1, 1899, p. 900.

the nature of pemphigus, as sometimes described, but is a distinct affection.

"It generally commences as a crack or streak, or from the beginning as a small superficial bright red ulcer. Occasionally in the tongue it begins in an inflammatory localized thickening just beneath the mucous membrane, which rapidly breaks down and forms an ulcer usually with a slough in the centre and considerable inflammatory redness around. It sometimes happens that the ulceration is preceded for a day or two by a heaping up of the epithelium, often forming a pale, gelatinous-looking ridge fitting in the spaces between the teeth. At other times, the ulcers are preceded by small gelatinous-looking bodies about the size of millet seeds, and, occasionally, by small vesicles; accompanying the ulcers is usually a considerable desquamating catarrh of the surface of the tongue. There is usually a good deal of burning sensation and great distress, accompanied by profuse salivation, and, if the ulcer is very indolent, with œdema of the parts around. If the lesion is situated in the mucous membrane of the lips, these may become so swollen as hardly to permit of the mouth being opened and the tongue protruded. The ulcers are produced by a distinct tropho-neurosis, and they are quite different from the common catarrhal or dyspeptic ulcer."

In one case recorded by Sibley the ulcers had appeared intermittently for twenty-three years.

Treatment.—Complete rest from worries is needful. Locally, the healing of the ulcers may be expedited by the application of tincture of iodine. The pain and distress may be mitigated by the use of cocaine, or, in severe cases, opium.

(3) LEUCOPLAKIA

Leucoplakia of the cheeks and the palate is of frequent occurrence in syphilitics and those addicted to heavy smoking. It is more usually seen in the muco-periosteum covering the back of the hard palate, and in marked cases presents the appearance of "ichthyosis." At times the condition may be limited, and give rise to a definite swelling of a white, cauliflower-like growth. H. P. Pickerill[1] has recorded a case of this character. On the tissue being removed and examined microscopically, the growth was found to consist of epithelial cells, which, instead of becoming squamous and then desquamating, had become swollen and

[1] "A Note on a Case of Ichthyosis Gingivæ," *Brit. Med. Journ.*, vol. xxx, p. 733.

hardened and remained *in situ* (fig. 741). The sub-mucous tissue was normal. This author considers the condition similar to the "pre-cancerous" conditions of the tongue described by H. T. Butlin.[1]

(C) PEMPHIGUS

The eruption of pemphigus may occur in the mouth, and one rare form, *pemphigus vegetans*, may remain localized to the mouth and adjacent cavities. The following case[2] will illustrate this condition.

Fig. 741.[3]

The patient was a man, aged 72, who complained of soreness in his mouth and inability to take solid food. On the roof of the mouth and on the epiglottis were patches of false membrane of considerable thickness, which, when removed, left a raw, bleeding surface. Some decayed teeth were extracted and antiseptics used, but blebs formed on the roof of the mouth, the soft palate, the cheeks, under the tongue, and on the posterior wall of the pharynx. Bacteriological examination of the membranes gave negative results. There was neither fœtor nor salivation. Whenever the patient attempted to masticate solid food a fresh crop of blebs appeared.

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[1] *Brit. Med. Journ.*, January 9, 1909.

[2] Dr. Lewis Maller, *New York Med. Journ.*, July 3, 1898.

[3] From *Brit. Dent. Journ.*

(D) PURPURA

In the severe form of purpura known as "purpura hæmorrhagica" the gums and mucous membranes may be the seat of the hæmorrhage. A similar condition is occasionally seen in patients who are the subjects of hæmophilia, spontaneous hæmorrhage occurring at the margin of the gums.

The treatment of purpura belongs to the domain of general medicine. The hæmorrhage from the gums can be treated by the use of astringents such as tannic acid, the application being combined with a certain amount of pressure.

(E) SCURVY

The effect of scurvy on the gums is that they become dark, turgid, spongy, and swollen, so as to hide a considerable portion of the surfaces of the teeth. At first the gums bleed readily; this is followed later on by a constant oozing. Ulceration and sloughing of the edges of the gums take place, leading to loosening and loss of the teeth and necrosis of portions of the jaws. In scurvy, the mucous membranes are anæmic, and there will be a strong contrast between the reddened gum and the pale mucous membrane covering the lips. The local symptoms are always associated with marked general symptoms indicative of the disease. In infantile scurvy changes in the gums are absent if no teeth have erupted, and in scorbutic adults the gums show no change if the patients are edentulous.

The treatment of scurvy cannot be dealt with here. Suffice it to say that the mouth must be kept quite clean by the constant use of antiseptic lotions.

(F) PERFORATING ULCERS OF THE MOUTH

Such ulcers, which are due to trophic changes, are occasionally seen in patients who are the subjects of *tabes dorsalis*.

As to the explanation of the lesion, there are two views: (1) that of Galippe, that it is the result of alveolar pyorrhœa aggravated by tabes; and (2) that of Baudet, that it is an atrophic tabetic lesion, due to the fifth nerve being affected, which begins by loss of the teeth and atrophy of the jaws, and sometimes terminates by ulceration and perforation into the maxillary sinus.

(G) TUBERCLE

Tuberculosis of the mucous membrane of the mouth is a rare condition and seldom arises as a primary lesion.

The changes in the mucous membrane are similar to those seen when the disease is located in the skin. The tubercular nodules are present as minute white points set in a red thickened membrane. Ulceration occurs at an early stage owing to "the constant maceration of the newly-formed abnormal tissues by the fluids of the mouth." The ulcerating patch has well-defined borders. "The most characteristic feature of tubercular ulcers of the mucous membrane of the mouth is the presence of minute tubercular nodules in the margins and underneath the layer of granulations."

(H) SYPHILITIC INFLAMMATION AND ULCERATION

Syphilis may affect the gums and oral mucous membrane in all stages.

The primary lesion may occur on the gums, tongue, or other parts, and often assumes an unusual appearance. Ulcers of peculiar appearance and uncertain origin should always be regarded with suspicion, and the possibility that they are of syphilitic origin should be carefully inquired into.

Secondary lesions may appear in the form of mucous tubercles in almost any part of the mouth; the favourite situations are the inner surfaces of the cheeks, the edges of the tongue and the lips. In weak and debilitated patients, the tubercle may break down, leaving an ulcer with a sinuous outline. The ulceration may extend and lead to extensive destruction of the tissue, followed, on healing, by adhesion of contiguous parts and extensive contraction.

In the tertiary stages the ulcerations are generally of a deep, excavated character, and are preceded by gummata, which, undergoing degeneration, produce the ulceration.

(I) ANEURISM

A case is recorded by J. H. Edward[1] in which the anterior palatine artery entered the mouth through an aperture in the centre of the suture between the palatine bones. The pressure of a denture at this part led to an aneurismal dilation of the vessel.

The various tumours arising in connection with the gums are described in chapter XXVII.

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[1] *Journ. Brit. Dent. Assoc.*, vol. xvi, p. 272.

CHAPTER XX

Saliva

(A) PHYSICAL CHARACTERS AND COMPOSITION

Mixed saliva consists of the secretions of the parotid, the submaxillary and the sublingual salivary glands together with the secretions of the buccal mucous glands. When collected from the mouth the fluid contains epithelial cells, salivary corpuscles, micro-organisms and other débris.

Mixed saliva freshly collected is a transparent, slightly opalescent and viscid fluid, but after standing for a short time it becomes slightly turbid. The turbidity is caused by the precipitation of calcium carbonate which, being held in solution by carbonic acid, is deposited as the acid escapes. The specific gravity of mixed saliva is 1002 to 1006. In health the reaction is alkaline. In man about 0·5 per cent. of the contents on an average consists of solids. According to Halliburton, the solid constituents which are found dissolved in mixed saliva may be classified as follows:—

Organic

(*a*) Mucin: may be precipitated by acetic acid.
(*b*) Ptyalin: an amylolytic ferment.
(*c*) Proteid: of the nature of a globulin.
(*d*) Potassium sulphocyanate.

Inorganic

(*e*) Sodium chloride: the salt in greatest abundance.
(*f*) Other salts: sodium carbonate, calcium phosphate and carbonate, magnesium phosphate, potassium chloride.

The peculiar character of the secretion of each of the glands is shown below:—

(*a*) *Parotid.* Clear and watery. On standing, a deposit appears, consisting principally of carbonate of lime. The total amount of solids is 0·3 to 0·5 per cent. There is no mucin.

(*b*) *Submaxillary.* Thick and viscid. Contains mucin and, on standing, deposits chloride of potassium and sodium. Solids 2·1

to 2·5 per cent., consisting of mucin and ptyalin, with potassium and sodium chlorides, and calcium and magnesium phosphates and carbonates.

(c) *Sublingual.* The richest in solids—about 2·75 per cent.—and the principal source of ptyalin. The salt in greatest abundance is phosphate of lime.

(d) *Mucous.* According to Bidder and Schmidt, the secretion contains water and mucin and inorganic salts of which the chief is sodium phosphate.

(B) CONDITIONS OF NORMAL SECRETION

The secretion of saliva is normally due to the reflex action called forth by various stimuli applied to different parts of the mouth. The afferent impulses are conveyed to the nerve centre by the lingual and glosso-pharyngeal nerves in the tongue and the sensory branches of the fifth nerve distributed to the mucous covering of the buccal cavity. The efferent impulses are represented by the chorda tympani in the submaxillary and sublingual glands, the auriculo-temporal nerve in the parotid gland, and by fibres of sympathetic nerves supplied to each gland. A flow of saliva can also be induced by means of stimuli conveyed via the optic, olfactory and auditory nerves.

Excellent research work on the secretion of saliva has been carried out by H. P. Pickerill and the following particulars are taken from the various papers which he has published.

Research work on salivary secretions in the past has invariably been carried out on animals, and mainly by electrical stimulus of the efferent nerves. Pickerill questions the efficiency of these methods, firstly, because a natural stimulus is not employed and secondly, because an electrical stimulus affects all the nerve fibres at one and the same time. There is reason to believe that two if not more different sets of nerve fibres exist, each of which specifically affects the salivary secretion and is normally excited by separate reflex stimuli in the mouth, and a stimulus which cannot be applied separately to each set of fibres would obviously give unsatisfactory results. He recommends that in experimental investigation the saliva should be obtained (1) from the human subject; (2) from a subject in whom there is apparently an average salivary activity; and (3) by natural or ordinary methods of stimulation, or, if in the "resting" stage, under known and constant conditions.

For the purpose of obtaining saliva the following plan was adopted:—

(i) A small canula made of thin German silver was inserted into

the parotid duct. (By bending the canula slightly it can be held by the duct.)

(ii) A "segregator" was constructed to obtain the sublingual and submaxillary secretions. This appliance was somewhat akin to a vulcanite denture with a hollow chamber made of soft vulcanized rubber attached on one side (see fig. 742). This chamber was open at the bottom, the margins being exactly applied to the floor of the mouth. A metal tube 3 mm. in diameter was inserted into the chamber, the orifice being as nearly as possible over the opening of the ducts. The metal tube was bent so as to pass into the buccal sulcus and a rubber tube was attached to transfer the secretion to a receptacle. Every endeavour was made to carry out the experiments under identical conditions and, for comparison, experiments on the saliva secreted during mastication and the "resting" saliva were undertaken. (By "resting" saliva is meant the saliva present in the mouth some hours after eating.) The total flow of saliva

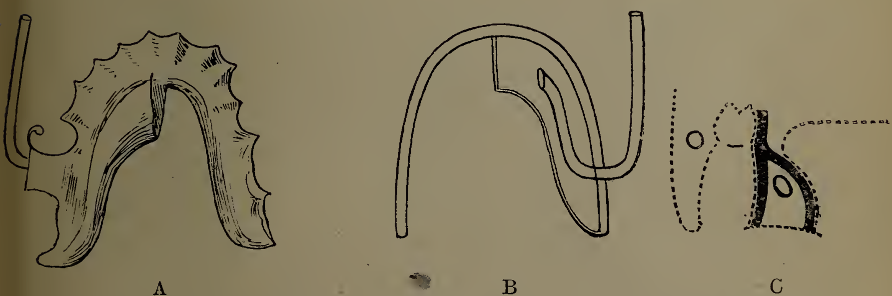

Fig. 742.—A, upper surface of segregator; B, under surface—diagrammatic; C, diagrammatic section of segregator in position.
(From Pickerill's "Dental Caries." *Baillière, Tindall and Cox.*)

per minute and the *total amount* of solids *per minute* present in the mouth were estimated.

Various foods were used as stimuli; for example, bread and butter, cake, bananas, carrots, meat, apple, lemon, &c. Some of the results obtained are given below.

(1) *Quantity and alkalinity.* The quantities were measured to 0·05 c.c. and the alkalinity estimated by titration with $\frac{N}{50}$ H_2SO_4. The indicator used was weak methyl orange. The alkalinity was expressed in c.c. of $\frac{N}{50}$ H_2SO_4, required to bring the methyl orange to neutral. The figures of the normal resting saliva were obtained by estimations of one individual's saliva on fifty consecutive days (Saturdays and Sundays excepted), two hours after a light mid-day meal which always consisted of the same things.

It was found that the quantity of saliva varies per minute both from the parotid and from the submaxillary and sublingual glands according to the different stimuli.

(*a*) In the case of the parotid gland one stimulus may produce ten times more secretion than another stimulus, and in the case of the submaxillary eight times as much.

(*b*) The total quantity may vary in the proportion of eight to one.

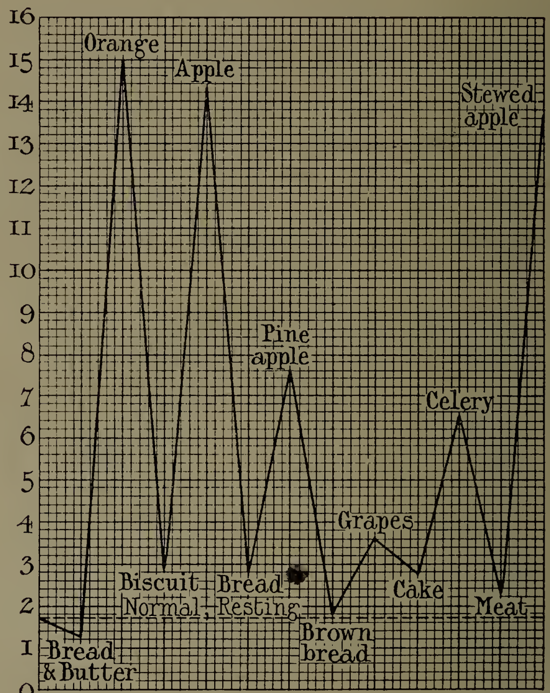

FIG. 743[1].—Chart showing the variation in salivary secretions during the mastication of various articles of diet.

(*c*) The parotid saliva never exceeds one-third of that from the submaxillary and sublingual glands and may be as low as one-thirtieth.

(*d*) The softest and least flavoured articles of diet produce the smallest secretion.

From the chart, fig. 743, it will be seen that the total alkalinity is far greater with a fruit stimulus than with a carbohydrate stimulus. The variations in the total output of saliva are similar to the variation in the total alkalinity.

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[1] From *Brit. Dent. Journ.*

An acid diet progressively increases the alkalinity of the secretion of the saliva. The use of alkaline dentifrices, on the other hand, has a marked depressing effect both on the amount of secretion and on the alkalinity.

(2) *Phosphates.* During the mastication of acid substances not only is the quantity of phosphates increased per c.c. but the amount per minute is also increased. Alkalies cause a diminution, but sodium chloride slightly increases the amount of phosphates.

(3) *Chlorides.* Saliva under normal conditions contains from three to five times as much chlorides as phosphates. Natural stimulation increases the chlorides more rapidly than the phosphates, but when depression occurs from the use of alkalies, the decrease of chlorides is proportionally three times as great as the decrease of phosphates.

(4) *Ptyalin.* Acid substances call forth the greatest amount of ptyalin ferment per minute, while substances like bread and butter are extremely feeble excitants of ptyalin secretion.

(C) ADAPTATION OF THE SALIVARY SECRETION TO DIET

This subject has been investigated by C. H. Neilson and O. P. Terry.[1] Experiments carried out on dogs have shown that the amylolytic power of the saliva of bread-fed dogs was greater than that of meat-fed dogs. A dog was fed for fourteen days on a meat diet, and the glands on one side were then removed. The dog was then placed on a bread diet for fourteen days after which the glands on the opposite side were removed. The extract of the glands removed after the meat feeding showed only a small amylolytic power, while the extract from the glands after the dog had been fed on bread showed a much greater amylolytic power.

(D) BACTERICIDAL PROPERTIES

Sanarelli[2] states that human saliva possesses the power of destroying micro-organisms when their number is not considerable, and even when it fails to destroy them, as in the case of the germ of pneumonia, it seems capable of modifying their normal characteristics by weakening them, and then rendering them completely inactive. Sanarelli experimented chiefly with the more common of the micro-organisms which are found in the mouths both of healthy and unhealthy individuals, namely, the *Staphylococcus*

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[1] *Amer. Journ. of Physiol.*, vol. xv, p. 406.

[2] *Centralblatt für Bakteriologie*, vol. x, p. 817.

pyogenes aureus, *Streptococcus pyogenes*, the bacillus of diphtheria, the *Micrococcus tetragenus*, the diplococcus of pneumonia, the typhoid bacillus and the cholera spirillum. The saliva was filtered with a Chamberland filter and experiments were practised by the plate method.

Hugenschmidt[1] records numerous experiments with filtered saliva, and he has come to the conclusion that "the bactericidal action of the saliva appears to be very problematical." He was only able to detect it on the torula and *Staphylococcus aureus*. The saliva, he considers, has an important mechanical action, as it dilutes the bacteria, glueing them together so that they are swallowed and destroyed in the stomach by the action of the gastric juices. In connection with these experiments it has been pointed out by Miller that the effect of filtering the saliva is to deprive it of the greater part of its nutrient matter, so that it contains but a small fraction of the organic matter usually present in culture media. The refusal of bacteria to grow in such a fluid is possibly due to inanition and cannot, therefore, be regarded as a proof of antiseptic action.

In a series of experiments carried out by Miller[2] this source of error was excluded. Bouillon of double strength made from beef extract, peptone and sugar was prepared, and 5 c.c. placed in three tubes, A, B and C. To tube A, 5 c.c. of the saliva of a person immune to caries were added; to tube B, 5 c.c. of the saliva of a person not immune; and to tube C, the control, 5 c.c. of water. By this means the strength of the bouillon was reduced to the normal. The saliva was filtered through a Chamberland filter. The three tubes were inoculated with a bacterium obtained from carious dentine and incubated. As a result of this experiment Miller found that the saliva exerted no retarding influence on the growth of the organism.

Experiments were then undertaken to test the rate of acid production. Bouillon, made of beef extract, peptone and sugar, of fivefold strength was taken, and to one part of bouillon four parts of each saliva were added. The tubes were then inoculated and the rate of acid production determined by the amount of a 5 per cent. solution of bicarbonate of soda required to neutralize the amount of acid formed. One experiment gave the following results:—

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[1] *Dental Cosmos*, October, 1896.

[2] "Introduction to the Study of Immunity in its Relation to the Diseases of the Mouth and Teeth," *Dental Cosmos*, vol. xlv, p. 1, January, 1903.

Relative Amount of Acid Formed.

	In 42 hours.	In 62 hours.	Total.
Saliva of A	9·5	5·5	15·0
,, B	9·0	7·0	16·0
,, C	10·0	7·5	17·5
Control water	9·0	7·0	16·0

The amount of acid produced in the control tube containing water and the three tubes containing saliva showed no appreciable variation. Further experiments were undertaken on the undiluted saliva, non-altered saliva, &c., with similar results, and the conclusion Miller came to was "That mixed human saliva—whether filtered or unfiltered in its normal state or condensed by evaporation over the water-bath, or at the temperature of the human body—does not possess the power to prevent or retard processes of fermentation or putrefaction.

Protective properties have been accredited to the buccal mucus. Miller, however, came to the conclusion that "growths of bacteria and fermentation and putrefaction processes take place in oral mucus quite as readily, if not more so, than in the mixed saliva of the same person." He says that "it seems hardly probable that the buccal mucus can contain any bactericidal property in view of the fact that the mucous membrane of the mouth is invariably found to be covered with large masses of bacteria." On the other hand, the action of mucus in other cavities of the body must not be lost sight of. Wurtz and Lermoyez have shown that "after three hours contact with the nasal mucus at 38° C. the spores of the *Bacillus anthracis* are killed, while the *Staphylococcus aureus*, the streptococcus and the *B. coli* are greatly attenuated." Thomson and Hewlett[1] also found the nasal mucus possessed a retarding influence, but no bactericidal property.

The mucus secreted normally by the cervix uteri destroys and attenuates the germs of the vagina and prevents them from penetrating into the uterine os; still further, in connection with the bronchi, Widal considers that "the innumerable glands which exist on the surface of the respiratory mucous membrane secrete constantly a mucus which has a bactericidal action." Arguing by analogy, it would certainly seem probable that the mucus in the mouth when healthy does exert a protective influence against infection.

The possibility of fresh saliva containing protective substances (alexins) is shown in the case of East Indian snake-charmers. These individuals treat snake-bites by applying saliva to the wounds,

[1] *Lancet*, 1897, p. 860.

they themselves having acquired immunity by being bitten first by very small snakes and gradually by larger ones, the antibodies thus formed in the blood passing into the saliva.

It is probable that *phagocytosis* plays an important rôle in protecting the oral cavity against pathogenic organisms. Hugenschmidt refers to the chemiotactile properties of mixed saliva, and shows that non-filtered human saliva possesses positive chemiotactile properties. This he demonstrates by the following experiments: Human saliva ejected in the morning was left for some time in an experiment glass; the upper part of the liquid, which had become clear, was then introduced in small quantities into capillary tubes which were each closed at one extremity; the tubes were then inserted into the peritoneal cavity of a guinea-pig and left for eight hours, after which they were removed, and, on being examined, leucocytes were found to have formed a dense plug 2 mm. long. In another experiment, in which the saliva was kept for twenty-four hours in an oven at 37° C., and in which the number of microbes had greatly increased, the plug formed by the leucocytes in the capillary tube was visibly larger, thus showing that the attraction exerted by the leucocytes is in relation to the intensity of the culture, and consequently with the quantity of the microbian products present in the liquid. From these experiments it may be inferred that when there exists in the interior of the alveolar process after an extraction, or in any other part of the buccal parietes, a cavity where the saliva can remain and become the medium of an abundant culture, the saliva presents chemiotactile properties in relation to the quantity of microbes which have developed in it. The leucocytes of the neighbourhood will be energetically attracted towards the diseased part, and will, in a very marked way, accomplish their protective action.

Experiments in which the saliva of a guinea-pig was introduced into the same animal's peritoneal cavity produced the same results as human saliva, thus demonstrating the fact that the saliva of one animal attracts the leucocytes of the same animal. After it had been proved that saliva possessed positive chemiotactile properties, experiments were made with a view of ascertaining whether the phagocytes of an animal are capable of englobing and digesting the microbes which are cultivated in the salivary secretions. That the phagocytes of an animal are capable of englobing and digesting the microbes which are present in the salivary secretions is shown by the following experiment:—

Human saliva which had been allowed to stand and clarify was mixed with leucocytes from guinea-pigs. The mixture was placed

in an oven at 37° C. for an hour, after which it was placed on slides, fixed, and coloured by Ehrlich's process. Microscopical examination of the slides showed that the leucocytes had taken up the microbes with great avidity. Similar experiments with the same animal gave similar results. In another experiment recorded, the activity of the destruction of the microbes by the phagocytes is clearly demonstrated. "A trace of saliva was taken from a guinea-pig and from this preparations were made and stained, some with methyl blue and others by the Gram method. This done, a wound was made in the gum and in the median line of the mandible, the mucous membrane being removed and the bone scraped. Twenty-four hours later the wounds presented a white coating consisting of leucocytes, almost all polynuclear, some mononuclear. These leucocytes, by proper stainings, were found to contain an abundance of microbes similar in form and character of stain to those seen in the preparation of the saliva. A considerable number of the englobed microbes were less energetically stained than those from the surrounding liquid, thus demonstrating their degeneration."

In the experiments above recorded the saliva was used unfiltered and therefore mixed with microbes. In order to test whether filtered saliva possessed these chemiotactile properties, the following experiment was carried out: Saliva filtered through a Chamberland filter was introduced into six capillary tubes each of which had one end closed. In six other tubes cholera culture was introduced, and into another six physiological serum. These three bunches, separately attached, were placed in the peritoneal cavity of a guinea-pig and left for ten hours. Examination at the end of that period showed dense plugs of leucocytes in the tubes containing cholera culture, but few leucocytes in the tubes containing filtered saliva, and no trace of any in the tubes containing physiological serum. "It would thus seem that the positive chemiotactile properties of mixed saliva depend upon the presence of micro-organisms."

But phagocytosis is probably not the only means by which the oral cavity is rendered immune to pathogenic organisms, for it is probable that the epithelial cells and also the vital antagonism of the microbes lend their aid. The epithelial cells of the oral cavity are constantly being replaced, this desquamation being especially active during the act of mastication. Although the epithelial cells do not possess phagocytic properties, nevertheless they have attached to their surface and are also to a certain extent penetrated by scattered bacteria. These cells on being dislodged are carried

away with the organisms to the stomach where the latter are destroyed.

Another factor to be considered in connection with the immunity of the oral cavity to infection may be the antagonism of organisms to one another, the organism not common to the mouth succumbing to those normally present. The following experiment, carried out by Miller on himself, throws light on this question. He thoroughly rinsed his mouth with a bouillon culture of *Bacillus prodigiosus* containing over 2,000,000,000 bacilli. The number of bacilli in a loop of his saliva was ascertained at the beginning of the experiment, and at the end of one, two, three and six hours, with these results:—

Bacteria at beginning	97,600
,, after 1 hour	1,220
,, ,, 2 hours	127
,, ,, 3 ,, ...	17
,, ,, 6 ,, ...	0

His mouth at the end of three hours was practically free from organisms. The elimination of pathogenic organisms such as those of tubercle, typhus, &c., which are constantly finding an entrance to the mouth, may be brought about by a struggle with the normal flora of the cavity.

To sum up, the facts quoted above would seem to indicate that the soft tissues of the mouth are rendered immune—

(1) By the process of phagocytosis.

(2) By the normal functional activity of the mouth, causing desquamation of the epithelial cells with the adherent bacteria, the latter being destroyed by the gastric juice.

(3) By the mutual antagonism of the micro-organisms.

(E) THE RELATION OF THE SALIVA TO CARIES OF THE TEETH

A free flow of saliva by cleansing the teeth of food débris lessens their liability to caries. The phosphates probably have a protective action upon the teeth. Lactic acid "readily combines with phosphates to form harmless lactates and the lactic acid will be more readily and rapidly satisfied if the phosphates are in solution, than if they are in a solid and extremely hard mass like enamel." "Acid phosphates may be formed, but there is no evidence to show that these, under such circumstances, can exert any effect upon the enamel surface."[1]

[1] The method adopted to estimate the phosphate was "that of titration with N/5 uranium nitrate. The saliva was diluted, and there was added a small quantity of sodium acetate acidified with acetic acid. The indicator used was potassium ferro-cyanide" (Pickerill).

Ptyalin, in Pickerill's opinion, is an important protective agent for the teeth. It converts the insoluble and adhesive substances, such as starch, into a soluble and easily removable substance (maltose) and, provided that there is a free flow of saliva, stagnation is obviated and circulation promoted. He considers that a small amount of ptyalin is harmful. His argument is as follows:—

(i) In the conversion of starch into maltose by the action of ptyalin, erythro-dextrin and achro-dextrin are formed as intermediate products.

(ii) The rapidity of action depends upon the amount of the ptyalin and its concentration.

(iii) If the ptyalin is present in considerable amount the conversion into maltose is rapid and it is quickly removed by the flow of saliva.

(iv) If the ptyalin is small in amount, the dextrin formed will remain longer and with the maltose cling to the teeth. The mouth organisms will convert the maltose into lactic acid and this in its turn will destroy the ptyalin with the result that the "starch is literally gummed to the teeth, to be slowly but surely transferred into lactic and other acids."

The effect of mucin may be harmful or beneficial. When partly dissolved it is very viscous and in this condition is harmful as it tends to bind food débris to the teeth and so promotes stagnation. Acid substances precipitate mucin and alkaline salts are taken down in the precipitate, and the teeth are coated with a thin organic alkaline film. The mucin is acted on by bacteria and alkaline products are formed which tend to neutralize any acid formed by fermentation.

The relation of potassium sulphocyanate to caries has been freely discussed during recent years. It is maintained by certain authors that the presence of sulphocyanates diminishes the liability to caries. The amount of potassium sulphocyanate in the saliva is very small, varying from 0·0075 per cent. to 0·03 per cent. Miller[1] has shown that potassium sulphocyanate in the strength met with in saliva has no retarding influence.

(F) SALIVARY CALCULI

A calculus occasionally forms in the ducts of the salivary glands. It may form in the substance of the gland, but this is very rare, as a deposit formed in this situation is usually washed into the duct. If the deposit is situated in the substance of the gland, it

[1] *Dental Cosmos*, January 1, 1903.

gives rise to serious inflammatory trouble; the flow of saliva from the duct of the gland is obstructed and the trouble may lead to abscess or even destruction of the gland.

A calculus is more frequently met with in the submaxillary ducts than in the parotid duct, and this is possibly due to the mucoid character of the submaxillary secretion and to the position of the duct rendering it more liable to injury.

Symptoms.—When a salivary calculus is deposited in the duct of a gland, the obstruction, which may be either as small as a millet seed or larger than a filbert, will give rise to a swelling of the duct and gland. Salivary calculi situated in the floor of the mouth may simulate ranula, from which they should be diagnosed by noting that in the case of salivary calculus the flow of saliva is stopped, and that a small probe cannot be passed along the duct, while careful digital examination will reveal a hard concretion in the duct.

At times, the presence of a salivary calculus in Wharton's duct will give rise to appearances and symptoms suggestive of malignant disease. In one case seen, the floor of the mouth was much swollen, the tongue pushed upwards, and there was a fungating excrescence surrounded by tissue in an indurated condition. The tissues covering the mandible and the neck were much swollen, and the lymphatic gland lying in the submaxillary region enlarged. The patient presented a cachectic appearance. The whole condition seemed typical of malignant disease.

In a case recorded by T. E. Constant, a calculus in the parotid duct caused symptoms simulating a dento-alveolar abscess.

Origin.—The cause of the formation of salivary calculi is not clear. It has been suggested that they arise in a manner similar to other calculi, by precipitation and secretion of the salts around a foreign body. This view is supported by the occasional presence of a nucleus of foreign matter within a salivary calculus. A minute foreign body can easily enter the main salivary ducts and form a nucleus.

Bland-Sutton[1] considers that the principal conditions determining the formation of gall-stones are catarrh of the epithelial lining of the gall-bladder plus the presence of micro-organisms, and it is possible that salivary calculi may arise in a similar way.

Size.—Salivary calculi vary considerably in size. They may weigh as much as 25 gr., and the fusiform-shaped calculi reach 1 in. in length.

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[1] "Gall-stones and Diseases of the Bile-ducts." Nisbet, 1907.

Treatment.—Treatment consists in making an incision over the hard swelling and removing the calculus. It is best to secure the concretion in a fixed position before making the incision. Cases remaining untreated may give rise to suppuration, either in the region of the duct or in the gland itself. The abscess at times opens externally and thus gives rise to a salivary fistula. Salivary calculus as a deposit on teeth will be considered in the following chapter.

A case in which six calculi were found in the parotid duct in a child aged 13 is recorded.[1]

(G) DEGENERATION OF THE SALIVARY GLANDS

Lymphoid degeneration of the salivary glands has been described by W. S. Handley.[2] The change consists in the total destruction of the epithelial elements of the gland accompanied by hypertrophy of the lymphoid elements. The microscopical structure of the gland becomes practically indistinguishable from that of the tonsil or of a lymphatic gland, and the saliva-secreting function of the gland is destroyed.

The clinical features of the condition are pain, tenderness and swelling of the gland, accompanied by a mucoid discharge. A small calculus is sometimes present in the duct. In the cases recorded, the primary change would appear to be chronic catarrh of the salivary duct due to bacterial invasion from the mouth. The most satisfactory treatment is excision of the gland.

A case of purulent discharge from both parotid glands has been placed on record by C. S. Tomes.[3] The trouble dated from an attack of typhus thirty years previously. The discharge was indistinguishable from pus, but its power of affecting starch had not been destroyed.

(H) SECONDARY PAROTITIS

This is an acute inflammatory affection of the parotid gland, and is distinguished from primary parotitis, "mumps," by:—

(1) Its appearance as a complication during the course of other affections.

(2) Its non-contagious character.

(3) Its tendency to suppurate and give rise to a parotid abscess.

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[1] *Amer. Med. Surg. Bull.*, July 25, 1897.

[2] *Trans. Odonto. Soc.*, vol. xxxix, p. 186.

[3] *Trans. Odonto. Soc.*, December, 1891, p. 32.

The condition occurs in the course of acute and chronic diseases, and also after operations, more especially those in which sepsis has been present. Secondary parotitis has been shown to be due to an ascending infection of Steno's duct, and to be dependent on a septic condition of the mouth. The duct is rendered liable to infection by conditions which tend to diminish the flow of the saliva and the consequent flushing of the duct, and by the presence of specific organisms in the cavity, such as those of typhoid fever, and the increase in number and virulence of the normal buccal organisms.

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CHAPTER XXI

Deposits on Teeth

Salivary Calculus—Subgingival Deposits—Stains

(A) SALIVARY CALCULUS

Several varieties of calculi are deposited on the teeth, the commonest being that derived mainly from the saliva and familiarly known as "tartar."

(1) Situations.—The lingual surfaces of the mandibular incisors and canines and the buccal surfaces of the maxillary molars are the most common situations of these deposits. The deposition of salivary calculus is assisted by: (*a*) Rough surfaces, as in "hypoplastic" teeth; (*b*) the presence of foreign bodies, such as wires or clasps on dentures which are not kept clean.

(2) Varieties.—Clinically there are two varieties, "soft" and "hard." The distinction is purely arbitrary. The difference depends upon the rapidity with which the deposit takes place. *Rapidly deposited tartar* is soft in character, buff-coloured, and occurs in large quantities. *Slowly deposited tartar* is dark and hard in character, and is exceedingly tenacious to the tooth surface. The colour of the tartar is affected by conditions which produce staining, such as tobacco smoking.

(3) Mode of Deposit.—The deposit starts at the cervical margin, and, as the calculus increases, it tends to assume a wedge shape, the base being towards the tooth. The deposit may attain to a large size. The deposit leads to more or less chronic gingivitis and absorption of the alveolar process. The friction of mastication removes the tartar. Disuse of teeth favours its deposition.

The calculus is formed by precipitation of the salts from the saliva. Calcium carbonate and calcium phosphate are insoluble in pure water, but soluble in water containing carbonic acid gas. When the saliva reaches the oral cavity, the carbonic acid gas passes out of solution and the lime salts are precipitated.

(4) Composition.—Berzelius gives the following composition :—

Phosphates of lime and magnesia	79·0
Salivary mucus	12·5
Ptyalin...	1·0
Animal matter soluble in HCl	7·5
	100·0

These figures can only be approximate. Dr. Stevenson gives the following analyses of the two varieties :—

	Water and Organic Matter.	Inorganic.
Soft tartar	21·48	78·52
Hard tartar	17·51	82·49

The deposit found on the buccal surfaces of the maxillary molars is composed almost entirely of calcium carbonate. The deposit on the lingual surfaces of the mandibular incisors contains much more calcium phosphate than carbonate, owing to the excess of the former in the submaxillary secretion.

(5) Treatment.—The treatment of salivary calculus consists in thoroughly removing all the deposits and polishing the surfaces of the teeth. The force for detaching the deposit may be used in a direction towards the gum or away from it. Force is used towards the gum when there is much tartar, and away from it when the quantity is small. When using force in a direction towards the gum, the right hand should be steadied by placing a finger or fingers upon the teeth, the cutting edge of the instrument being placed upon the tartar and a pushing motion used, when the tartar will be found to come off in large flakes. The greater part of the tartar can be removed in this way, the remaining adherent portions being removed in a direction from below upwards, the instrument being prevented from slipping by supporting the hand on the cutting surface of the teeth. When there is much deposit, it will often be necessary to see the patient more than once, as it is quite impossible to effect complete removal at the first sitting. At the completion of the scaling, the teeth must be polished with fine pumice applied by means of a circular brush on the dental engine.

(B) SUBGINGIVAL DEPOSITS

In dealing with marginal gingivitis and also chronic periodontitis, reference was made to the frequent presence of **calculus under cover of the gum margin.** In character it is hard and dark (p. 618), and is found more frequently on the approximal than on the labial and palatal surfaces. The source of this deposit is not clear. It probably originates from some abnormal secretion of the gingival organ in combination with the discharges from the marginal gingivitis. The presence of the calculus is generally marked by a

hyperæmic condition of the gum margin. The roots of teeth which have been the subject of chronic suppurative periodontitis are often covered with a calcareous deposit (see figs. 744 to 746). Analyses of these deposits show them to be composed mainly of phosphates. Oxalates are sometimes present.

FIG. 744.—Showing well-marked deposit around the neck of a mandibular molar.

FIG. 745.—A maxillary molar showing large deposit of calculus on the apical portion of the palatine root.

FIG. 746.—A maxillary molar showing irregular deposit of calculus over a large portion of the surface of the root.

Occasionally, calculus is present and yet the gum tissues appear to be quite healthy, but when this is the case it is probable that marginal gingivitis has occurred at an earlier period.

Treatment.—The deposit must be removed and the condition of the gum, or periodontal membrane, treated.

(C) STAINS[1]

(1) Green Stain.—A green stain is often found on the teeth, especially in the young. The colour varies from a greyish-green to bluish-green. It appears more frequently on the maxillary than on the mandibular teeth. The labial surfaces of the anterior maxillary teeth are the most frequent sites, the discoloration commencing at the gingival margin and encroaching on the surfaces in a direction towards the cutting margin. At times, more than half the surface is covered. The stain may extend to the approximal or even to the gingival surfaces. The stain may be limited to any pits, grooves, or depressions present on the surface of the tooth. The green stain is nearly always a sign of lack of cleanliness on the part of the patient. The stain is intimately connected with the enamel cuticle. Removal of the stain by acids leaves a colourless surface behind. Green stain may occur beyond the enamel margin on the teeth of adults.

[1] The matter contained in the following section relating to "stains," has been obtained almost entirely from an excellent paper by Dr. Miller (*Dental Cosmos*, April, 1894) entitled "The Deposits upon the Teeth with Special Reference to Green and Metallic Deposits."

Cause.—The origin of green stain is not clear. The following facts are known: The colouring matter is characterized by its insolubility in nearly all the ordinary solvents, viz., glycerine, alcohol, chloroform, turpentine, &c.; tincture of iodine has no marked decolorizing effect. The colouring matter is rapidly destroyed by chlorine and hydrogen peroxide. Calcination experiments show that the green stain deposit may be either of an organic or inorganic nature. The theory that the green stain is produced by chlorophyl is negatived by the fact that the stain is not soluble in ether, chlorophyl being readily soluble in ether. In some conditions there is reason to believe from experimental investigations that the green colour is to be attributed to the presence of sulpho-methæmoglobin.

The relation of green stain to enamel decalcification is not clear. When the stain is removed the enamel appears quite normal in the majority of cases, but in some cases the surface shows signs of decalcification.

Treatment.—The stain should be removed by means of suitable wheels or brushes on the dental engine, a little powdered pumice stone being used to increase the abrasive action. Acid applications are *not* to be used.

(2) Metallic Stains.—(*a*) *Copper.*—Workers in copper invariably show a green stain upon their teeth. Miller examined 150 persons who had been working in copper for more than a year, and found distinct discoloration of the teeth in all of them. The colour varies from green to dark dirty green, reddish-green, bluish-green, greenish-blue to bluish-purple, the latter being seen in "phosphor-bronze" workers. Persons using brass musical instruments at times show staining of the teeth.

In copper workers, the gingival margin is hyperæmic, owing to irritation from the more or less oxidized particles of the metal which may have worked their way up into the gums.

(*b*) *Iron.*—Iron seems to produce a brown stain of varying tints. In workers in iron, Miller found that nearly all showed brown spots or deposits on their teeth, the mandibular teeth being more frequently the seat of discoloration than the maxillary. Medicines containing iron may stain the teeth if the mouth is not cleansed each time after taking the medicine. The forms of iron detrimental to the teeth are those containing free acid, such as the perchloride.

(*c*) *Mercury.*—Deposits of mercury in the form of sulphide are seen on teeth filled with amalgam. These deposits occur also on the teeth of patients subjected to prolonged mercurial treatment, the mercury affecting the teeth through the saliva. The stain may

be due to the use of mouth-washes containing mercury. The presence of the mercury on the teeth can be demonstrated by chemical tests.

(*d*) *Lead.*—Lead poisoning may produce a blue line in the gum margins (p. 584). According to Hirt,[1] in chronic lead poisoning the teeth are discoloured and appear dark brown at the necks, shading to light brown towards the occluding surfaces.

(*e*) *Nickel.*—A tooth from the mouth of a worker in nickel is figured by Miller. The deposit is thick and of an opaque bluish to greenish-black colour.

(*f*) *Silver.*—Silver, when used in the mouth, produces a dark stain which is due to the formation of the sulphide. Silver employed in the form of silver nitrate stains the dentine and cementum black.

Treatment of Stains.—The various stains can be easily removed by the use of abrasives.

[1] Quoted by Miller.

CHAPTER XXII

Odontomes

The word "tumour" means a swelling and in the early days of medical writings was applied to any abnormal swelling such as the lesions of actino-mycosis, the gummatous stage of syphilis. The word is now applied only to new growths (neoplasms) which are not the result of inflammatory processes or hyperplasia. The tissue forming a tumour varies; some tumours consist of simple forms of tissue such as epithelium, while in others the tissue resembles highly developed forms such as bone. But the tissue of which a tumour is composed does not follow the ordinary laws of growth but in the manner of its growth seems to possess a law unto itself. The power of growth possessed by tumours differentiates them from abnormalities which are due to inherent developmental defects. In the majority of tumours growth is continuous, but there are exceptions, such as in the osteoma where, when ossification is complete, growth ceases.

The word "odontome" should, we consider, be confined to those abnormal conditions of the teeth which correspond clinically to the class of abnormality usually defined as a tumour.

In the excellent report on odontomes issued by the British Dental Association, the authors have included a number of abnormalities of the teeth which cannot be classed as tumours—indeed can only be regarded as abnormalities of defect. Here it is proposed to confine the term to tumour diseases of the teeth and to adopt the definition as suggested by Bland-Sutton that "an odontome is a tumour composed of dental tissues in varying proportions and different degrees of development, arising from tooth germs or teeth still in the process of growth."

Odontomes are classified by Bland-Sutton in the last edition (1917) of his book on Tumours as follows:—

(1) Epithelial odontomes: from the enamel organ.
(2) Follicular odontomes
(3) Fibrous odontomes } from the tooth follicle.
(4) Cementomes

(5) Compound follicular odontomes
(6) Radicular odontomes: from the tooth papillæ.
(7) Composite odontomes: from the whole tooth germ.

(1) EPITHELIAL ODONTOMES

According to Bland-Sutton, " These tumours occur, as a rule, in the mandible, but they have been observed in the maxilla. They

Fig. 747.—" Section of an epithelial odontome showing honeycombed appearance " (Bland-Sutton).

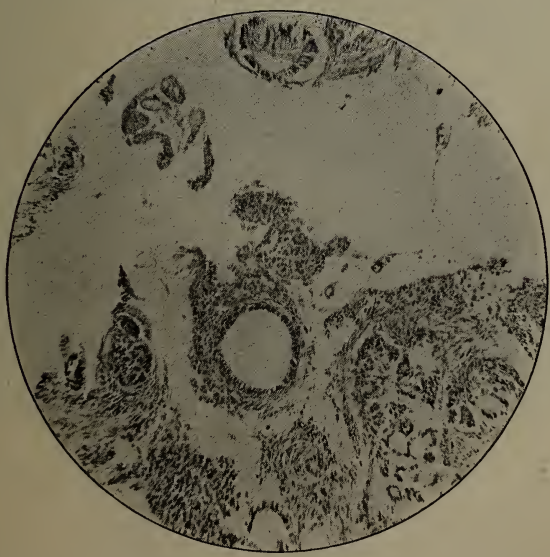

Fig. 748.—From an epithelial odontome described by W. W. James, *Proc. Roy. Soc. Med.* (Odonto. Sect.), vol. ii, p. 171.

have a fairly firm capsule, and in section display a congeries of cysts of various shapes and sizes; but the loculi rarely exceed 2 cm. in diameter. The cysts are separated by thin fibrous septa, sometimes ossified. The cavities contain brown fluid. The growing portions of the tumour have a reddish tint " (fig. 747).

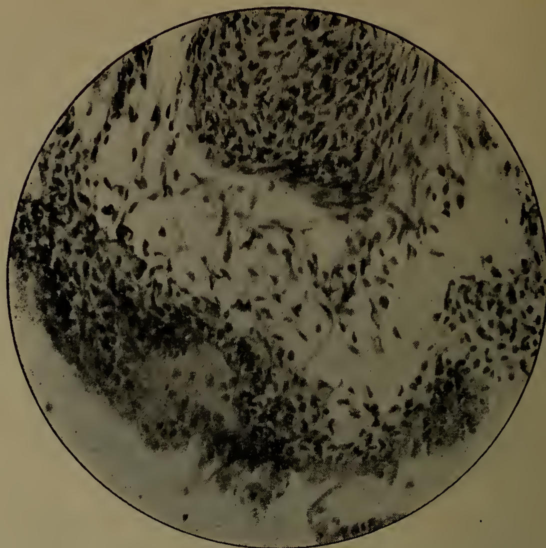

FIG. 749.—Section showing cells resembling those of the stellate reticulum of the enamel organ. From an epithelial odontome described by W. W. James, *Proc. Roy. Soc. Med.* (Odonto. Sect.), vol. ii, p. 171.

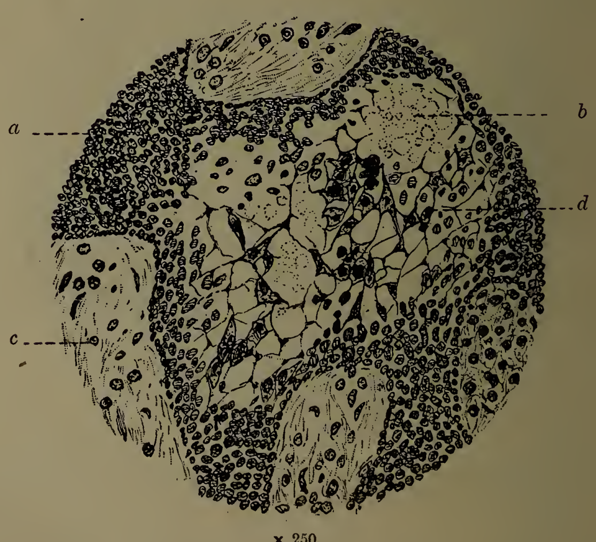

FIG. 750.—Epithelial cells in epithelial odontome breaking down and forming commencement of a cyst (from a drawing by A. Hopewell-Smith). *a*, epithelium; *b*, colloid appearance of earliest contents of cyst; *c*, mesoblastic tissue which constitutes the mass of the odontome; *d*, stellate character of epithelial cells.

"Histologically, an epithelial odontome consists of branching and anastomosing columns of epithelium, portions of which form alveoli. The cells lining the alveoli vary in shape; those of the outer layer are columnar; the central cells degenerate and give rise to tissue resembling the stellate reticulum of an enamel organ." Sections from an epithelial odontome are shown in figs. 748 to 750.

Epithelial odontomes probably originate in aberration of enamel organs of teeth which, under normal conditions, should go on to

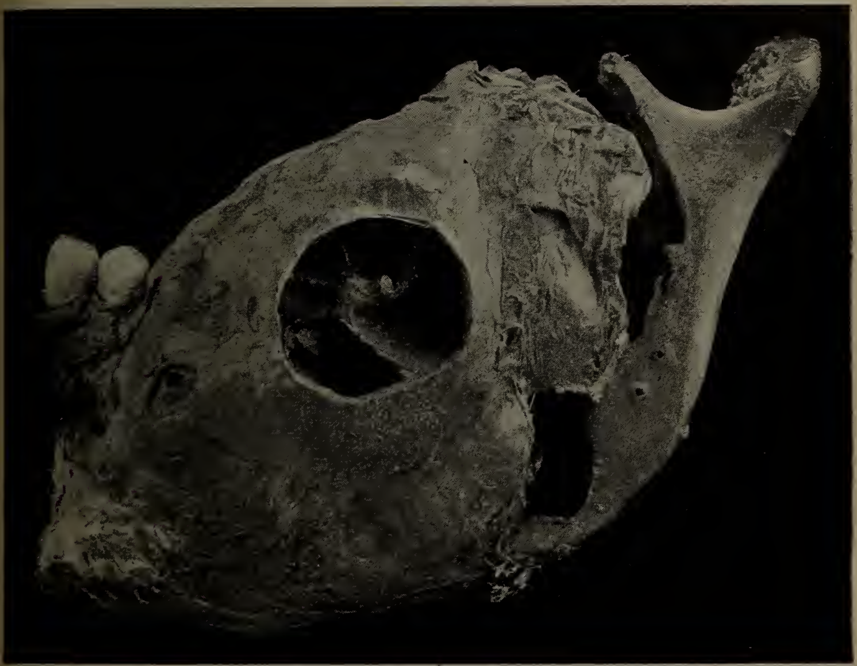

Fig. 751.[1]—Left half of the mandible affected by an epithelial odontone, No. 2198 Museum Royal College of Surgeons of England.

full development, or they may arise from epithelial ingrowths around the dental alveoli, some of which should, perhaps, be regarded as the representatives of teeth suppressed in the process of evolution.

Epithelial odontomes may involve a considerable portion of the bone, the walls of the jaw-bone becoming expanded and, in places, entirely destroyed, as seen in the specimen shown in fig. 751.

[1] From the Reports on Odontomes (*Brit. Dent. Assoc.*).

These odontomes give rise to a growth which is often insidious and slow in progress, extending in some cases over a period of twenty years. "A growth in the neighbourhood of the alveolar process is noticed, the swelling gradually increases, and the tooth overlying becomes loosened and may fall out. Not infrequently a glairy fluid is discharged from a vacant alveolus, the orifice of which may become ulcerated." The surface of the swelling is often lobulated, and may therefore be mistaken for a myeloma.

The **treatment** consists in opening up the cyst, care being taken to break down all the loculi and thoroughly remove the cyst wall. Should the growth return, free excision must be resorted to.

Eve[1] considers that some of the tumours described as spheroidal or columnar-celled carcinoma, should be classified as epithelial odontomes. He records the case of a tumour of seven weeks' growth which sprang from the alveolar process between the maxillary central incisors. The patient was a boy, aged eleven years, and the growth was entirely confined to the alveolar process and did not extend either to the inferior meatus or the maxillary sinus. The microscopical characters of the growth are shown in figs. 752 and 753.

"Fig. 752, from the centre of the tumour, shows columnar cells, arranged in rounded masses or in tubulous columns with a central space formed by degeneration of the central cells."

"Fig. 753, taken vertically through the gum, shows the columnar-celled growth beneath, but entirely distinct from the epithelium of the gum."

All multilocular cystic tumours must not be regarded as epithelial odontomes and in Bland-Sutton's opinion many of these tumours are endotheliomas.

(2) FOLLICULAR ODONTOMES (DENTIGEROUS CYSTS)

If a section of a jaw be made so as to include a tooth about to erupt, it will be noticed that the tooth is surrounded by a membrane (the tooth follicle) and that both tooth and membrane are completely enclosed in a capsule of bone. The membrane is adherent to the root of the tooth, but is slightly separated from the enamel, and in the space between the enamel and the capsule a small quantity of fluid may be found.

In the follicular odontome the interval between the tooth follicle and the tooth surface is increased, and the cavity is occupied by a

[1] "The Pathology and Treatment of Tumours of the Jaws," *Brit. Med. Journ.*, June 29, 1907.

cystic fluid. As the fluid collects, the bony surroundings of the tooth are absorbed and, at the same time, fresh bone is deposited

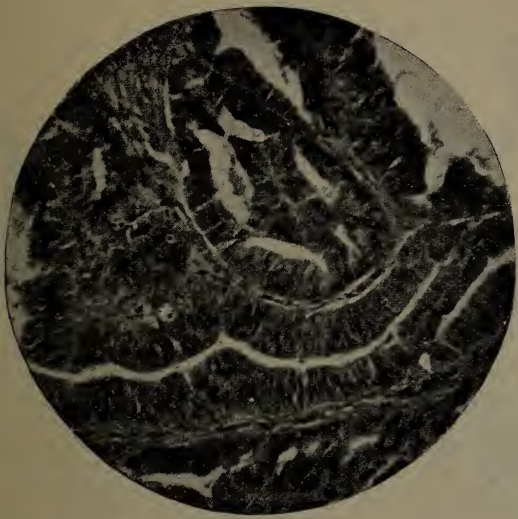

FIG. 752.—(High power.) Growth from alveolar process of maxilla, composed of rounded and elongated spaces lined with columnar epithelium. (Eve.)

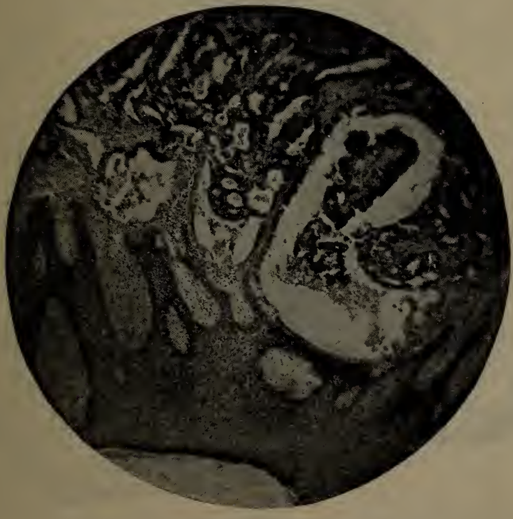

FIG. 753.—(Low power.) This section is taken vertically through the gum; beneath this, and distinct from it, is the columnar-celled growth undergoing cystic degeneration. (Eve.)

on the outer side of the jaw (figs. 754 and 755). In this way the jaw may become enormously expanded as shown in fig. 756. In the maxilla, the cyst may encroach upon the cavity of the sinus.

Sections through the walls of follicular odontomes show that they are formed of fibrous tissue with an internal lining of epithelium. A section through the wall of a follicular odontome exhibit-

Fig. 754.

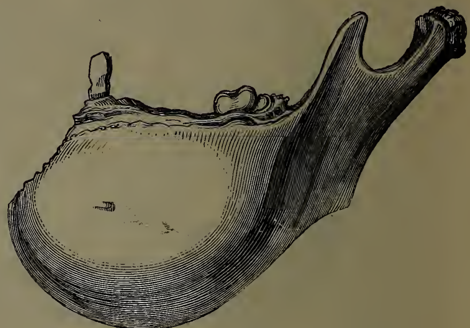

Fig. 755.

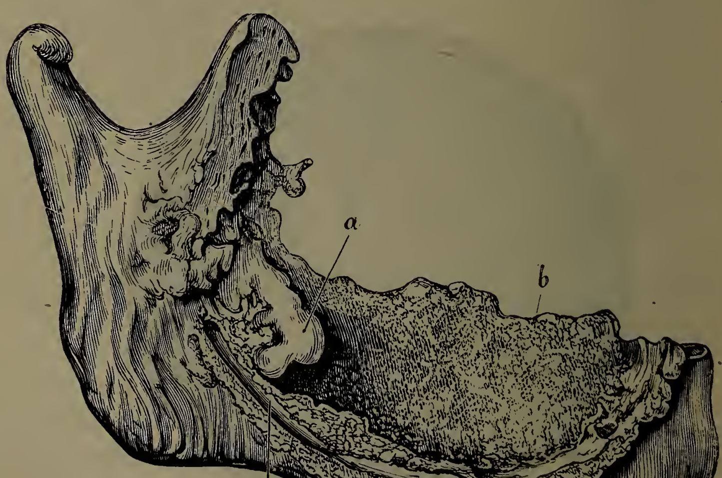

Fig. 756.—(a) tooth; (b) inner wall of cyst; (c) canal for mandibular nerve. (From Heath.)

ing the epithelial lining is shown in fig. 757. The epithelial lining cannot always be demonstrated probably because it is destroyed in the process of preparing the specimen. A tooth is generally found

projecting into the cavity, the roots, frequently only partially formed (fig. 758), being embedded in the cyst wall. The tooth sometimes lies free in the cavity of the cyst. W. H. Dolamore[1] has drawn attention to the fact that the tooth at times lies outside the cyst cavity. He records the case of a cyst in connection with a maxillary

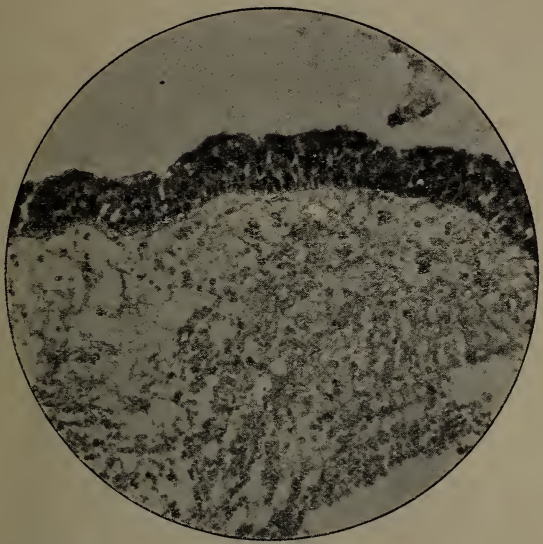

FIG. 757.[2]—Section of the cyst wall showing the epithelial lining.

FIG. 758.[3]—A follicular odontome (natural size).

central incisor, where it was necessary to divide the cyst membrane before removing the tooth. In the same paper he gives an illustration of the mandible of a sheep where it would appear that the cyst was developed external to the crypt of the incisor.

[1] *Royal Dental Hospital Reports*, 1911, p. 42, and 1913, p. 60.
[2] From the *Proc. Roy. Soc. Med.*
[3] From *Trans. Odonto. Soc.*, vol. xxvi, p. 182.

Teeth from follicular odontomes sometimes show an absence of Nasmyth's membrane. The fluid from a follicular odontome is generally of a yellowish, glairy character and contains crystals of cholesterin.

The walls of follicular odontomes may undergo calcification. An example is described by Salter[1] (fig. 759). The cyst had invaded the maxillary sinus. A feature of this case was the development of the cyst in connection with a supernumerary tooth. Suppuration is another secondary change, and is more commonly met with,

Fig. 759.

according to Bland-Sutton, in the lower animals. Complete disappearance of the fluid contents of the cyst has been observed by Heath.[2]

Cases of multiple cysts have been recorded. In a case recorded by Salter, cysts occurred on both sides of the maxilla of a young girl.

In a case recorded by W. Hern,[3] there were three cysts, two in the maxilla in connection with the lateral incisors, and one in the mandible around the unerupted left canine.

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[1] "Dental Pathology and Surgery," p. 219.
[2] "Injuries and Diseases of the Jaw." Fourth edition, p. 189.
[3] *Trans. Odonto. Soc.*, vol. xxvi, N.S. p. 91.

Follicular odontomes may develop at any age, but they are generally met with in young adults. They occur with about equal frequency in the maxilla and the mandible. They may arise in connection with any tooth, but the majority of cases are associated with the canine. Occasionally they arise in connection with supernumerary teeth. Follicular odontomes are very rarely associated with the deciduous teeth.

Opinions differ as to the source of the cells from which the cyst is derived. Hopewell-Smith is of the opinion that the cyst is due to degeneration of the cells of the stellate reticulum; others consider that the cyst arises from the cells of the external epithelium or from the more superficial cells of the tooth band. Epithelial remnants are found in the periodontal membrane and it is quite possible that such remnants are present in tooth capsules and that the cyst may sometimes originate in a manner similar to the dental cyst.

Signs and Symptoms.—Follicular odontomes produce slow-growing swellings, leading in the mandible to an expansion of the walls, while in the maxilla they frequently invade the sinus and may give rise to a distension of its walls. No pain is usually experienced unless suppuration has taken place. Upon manipulation of the swelling, the bony walls will often (but by no means always) yield to pressure and resume their shape as soon as the pressure is removed, the movement producing a curious kind of crepitation which has been termed "crackling." Occasionally, the bony wall does not exist and distinct fluctuation can be obtained. There is usually a history of absence of a tooth in the region of the swelling, and this is an important diagnostic sign.

The *differential diagnosis* from other tumours in the mouth is dealt with in chapter XXXIII.

Treatment.—Treatment consists in removal. The muco-periosteum covering the cyst wall is first reflected and the bony wall divided and in great part removed. The tumour is then dissected out.

(3) FIBROUS ODONTOMES

The external parts of the tooth sac are composed of fibrous tissue and if this tissue becomes hypertrophied a fibrous odontome is formed. The nature of these odontomes is shown in fig. 760. Under the microscope, the thickened follicle is found to be composed of fibrous tissue, laminated in character and at times partly ossified. In the lower animals these odontomes are generally symmetrical, and in one case, that of a dasyure, the skeleton was softened by

rickets. The presence of rickets in this case may have been an accidental circumstance, but in view of the fact that rickets seems to thicken the membrane which covers growing bone, it is not improbable that *there may be some relation between rickets and this class of odontome.*

Bland-Sutton contends that many of the fibroid and fibro-cellular tumours of the jaw which have been recorded are really examples of this form of odontome.

An odontome of this variety is described by Jordan Lloyd under the name of endosteal fibroma.[1] The patient, a girl aged 8, was the subject of a large swelling on the right side of the mandible, extending from the angle of the bone to within an inch of the symphysis. The deciduous and first permanent molars on that side were missing, the former having been extracted. The tumour was exposed by removing the outer plate of bone and was shelled out of its bed without difficulty. It was found to be attached only at its lower and posterior part, and was lying over the first permanent

FIG. 760.[2]—Portion of the skull of a dasyure, showing a fibrous odontome in section. The tumour was intimately connected with a molar tooth. (Bland-Sutton.)

molar which was displaced to the lower border of the mandible. The following is the description of the tumour: "It measured nearly three inches in length, two in depth, and nearly one and a half in thickness. It was of uniform pearly colour and of a regular tough consistence. At its lower and hinder part was a large well-formed permanent molar tooth lying with its crown against the tumour to which it was held in organic connection by a delicate fibrous membrane passing from the outer surface of the tooth roots to the delicate connective tissue capsule which covered the tumour." A microscopical examination showed the growth to be "closely

[1] *Journ. Brit. Dent. Assoc.*, vol. xiv, p. 564.
[2] From *Trans. Odonto. Soc.*

allied to fibrous tissue on the one hand, and to fibrous cartilage on the other, rather nearer the former than the latter."

(4) CEMENTOMES

These odontomes are produced by the ossification of fibrous odontomes, the resulting tissue being cementum. They are rare in man, but common in horses and ruminants. The growth resembles cementum in character and causes a hard tumour of the jaw, generally painless in the early stages, but later giving rise to pain which is apt to be mistaken for periostitis or necrosis. Fig. 761 is

FIG. 761.

the drawing of a cementome recorded by Dr. Forget; the odontome was about the size of a pigeon's egg and came away with a carious molar which he decided to extract before opening the tumour.

FIG. 762.—Section through fig. 761.

The possible association of fibrous odontomes and cementomes with rickets is suggested by a case, recorded by Bland-Sutton,[1] in which a cementome was found in the position of the right mandibular molar of a boy who presented unmistakable evidence of rickets.

(5) COMPOUND FOLLICULAR ODONTOMES

Under this heading are described cysts which contain a great number of small masses of dental tissue and, in some instances, bone. Several cases have been reported in man, while Logan has

[1] See "Tumours, Innocent and Malignant," Sixth edition, p. 236.

recorded one in a horse and Bland-Sutton one in a thar. Of the cases recorded in man, the first is reported in the *Transactions of the Odontological Society* (vol. iii, p. 282, O.S.), and may be taken as a type of this form of odontome. The patient was a female, aged 27; the cyst developed in the right maxilla, and was first noticed at the age of 12. The first molar, the two premolars, and the canine were absent. When first seen, suppuration had supervened and probably some of the calcified contents of the cyst had been lost. Twenty-eight denticles were removed—nine were tiny single teeth, each perfect in itself, with conical roots and crowns tipped with enamel. Six masses were built up of adherent single teeth, while the remaining denticles were exceedingly small.

The character of the denticles from these cysts varies. In one case recorded,[1] two of the fragments were fairly formed teeth and to one of the fragments bone similar to that of the alveolar process was attached; in another case[2] the denticles, fifty in number, were composed entirely of cementum; while in a curious tumour probably belonging to this group[3] the right maxilla of a girl, aged 11, was distended by a swelling which contained over 500 pieces of true bone similar to that forming the alveolar process.

In fig. 763 will be seen drawings of denticles removed from compound follicular odontomes.

The case described by Bland-Sutton in the thar[4] has thrown light upon the nature of these interesting cysts. He describes the condition he found as follows: "Each antrum contained, in fact, a cyst with dense thick walls. The outer shell was of bone, lined with thick fibrous tissue. The interior was occupied with denticles, fragments of cementum and bone of varying shapes and sizes, amounting to nearly three hundred. Those in the middle of the cyst were glued together by thick pus mixed with hay and chaff, while the peripheral fragments were embedded in fibrous tissue or sprouted from the cyst wall (fig. 764).

The **treatment** of compound follicular odontomes is similar to that of the follicular odontomes already described.

(6) RADICULAR ODONTOMES

Radicular odontomes arise after the completion of the crown and during the formation of the root.

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[1] *Trans. Odonto. Soc.*, vol. cxi, p. 366, Old Series.

[2] "A Case of Compound Follicular Odontome," A. W. de Roaldes, *New York Med. Journ.*, 1894, vol. lix, p. 612.

[3] Recorded by Bland-Sutton, *Trans. Odonto. Soc.*, vol. xx, p. 185.

[4] *Trans. Odonto. Soc.*, vol. xx, p. 185.

FIG. 763.[1]

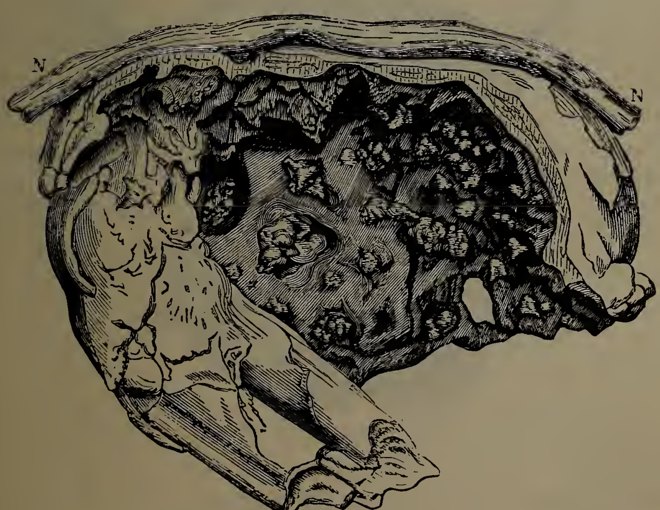

FIG. 764.[1]—Section through the maxilla of a thar, showing the cyst *in situ*. (N) the maxillary division of the fifth nerve. (Bland-Sutton.)

[1] From *Trans. Odonto. Soc.*

Radicular odontomes are comparatively common in the lower animals, more especially those whose teeth grow from persistent pulps. In animals, radicular odontomes are not uncommonly multiple, and, in one instance recorded by Bland-Sutton,[1] an odontome existed at the base of each incisor tooth in the maxilla and mandible (fig. 765).

Fig. 765.[2]—Hard palate of marmot. Odontomes connected with the roots of the upper incisor teeth appearing in the hard palate. (Bland-Sutton.)

Fig. 766.[2]

The specimen shown in fig. 766 was removed from the maxilla of a man aged 45. The patient had suffered much pain, and a sinus connected with the growth had opened on the face. C. Tomes made a microscopical examination of this specimen, the details of

[1] *Trans. Odonto. Soc.*, vol. xx, p. 65.
[2] From *Trans. Odonto. Soc.*

which are to be found in the *Transactions of the Odontological Society*, vol. iv, p. 82.

Another remarkable specimen is in the Museum of the Royal College of Surgeons of England (figs. 767 and 768). This tumour was examined by S. J. Salter.[1] The main mass of the tumour is composed "of a confused mass of bone-structure and dentine-structure, arranged around and separating an elaborate vascular network of the same character as that of a dentinal pulp." The upper two-thirds of this mass is covered with a layer of true dentine, the outer portion of the growth being composed of cementum.

An odontome of this class, which occurred in the practice of R. Markham, is shown in figs. 769 and 770. The tumour was examined and described by G. Watson.[2] The odontome was in connection with the maxillary left third molar and must have considerably encroached upon the cavity of the sinus. The structure consists of an outer layer of irregularly laminated cementum, highly vascular, and containing numerous well-marked lacunæ. The main portion is composed of a narrow band of very intricate convolutions of white and yellow tissue, namely, vaso-dentine and osteo-dentine (fig. 770).

The odontome seen in figs. 771 and 772 consists in a large globular swelling about the size of a full-grown acorn, involving one root of a four-rooted maxillary molar. On dividing the tooth with a saw, the globular swelling was found to be hollow, and lined with a tissue which presented distinct evidence of having been soft in character. The original pulp chamber is almost entirely filled up with a form of secondary dentine (fig. 773, *a*), presenting very little structure beyond a few blood-vessels. The globular swelling itself is bordered by a layer of cementum (fig. 773, *b*), the lacunæ being more numerous on the right side of the specimen. This outside cemental layer is bounded internally—

(i) On the right side with dentine fairly regular in type, and continuous with the dentine of the main body of the tooth. The dentinal layer is succeeded by one cemental in character.

(ii) Towards the base, by a dentinal tissue presenting few tubuli.

(iii) To the left, by tissue irregular in type, containing large blood-vessels and irregularly shaped lacunæ, with a few dentinal tubes (fig. 773, *d*), and which, as far as can be ascertained, is continuous with the secondary dentine in the pulp chamber. Inside this layer is a tissue of rather different pattern, but still cemental in character. At one spot (fig. 773, *c*), a transverse section of

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[1] "Dental Pathology and Surgery," by S. J. Salter, p. 125.
[2] *Journ. Brit. Dent. Assoc.*, vol. xv, p. 667.

FIG. 767.—(Salter.)

FIG. 768. (Salter.)

FIG. 769.[1]

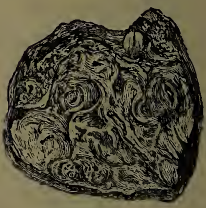

FIG. 770.[1]

FIG. 771.[1]

FIG. 772.[1]

[1] From *Journ. Brit. Dent. Assoc.*

dentine appears. The aberration seems to have consisted of an overgrowth of one radicle of the pulp, followed by calcification in a direction from without inwards.

A growth (figs. 774 and 775), which is probably a type of radicular odontome, is described in Wedl's "Atlas of the Pathology

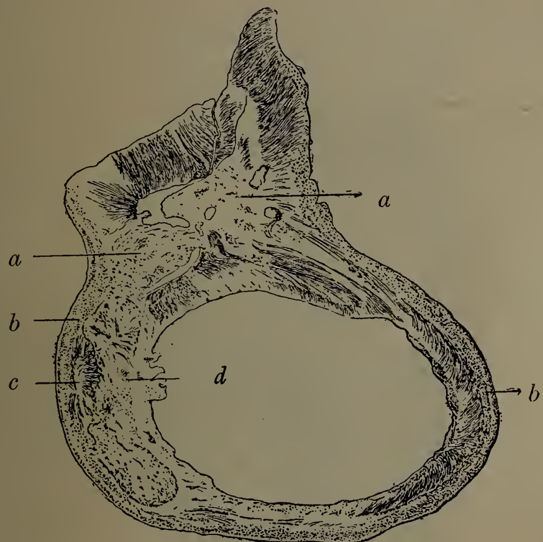

FIG. 773.[1]

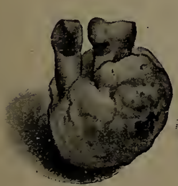

FIG. 774.[2] FIG. 775.[2]

of the Teeth" (Second Edition). The patient was a boy, aged 11½, and the swelling occurred in the mandible in the region of the first deciduous molar. The tumour was very sensitive to pressure, owing to severe periostitis. After removal, it was found to be composed of a mass of tissue about the size of a large cherry, intimately coalescent with the deciduous canine and first molar.

[1] From *Journ. Brit. Dent. Assoc.*

[2] Copied by permission from Wedl's "Atlas of the Pathology of the Teeth."

It was covered with a distinct membrane of connective tissue which was closely adherent to the hard tissue. A section of the growth showed that it consisted of hard tissue containing cavities filled with connective tissue and blood-vessels (fig. 776). The distal root of the molar showed considerable absorption. Microscopical examination showed the hard tissue to be a rudimentary dentine, which has remained stationary at the stage of development of globules with interglobular spaces.

FIG. 776.[1]

An odontome similar in character to the foregoing is recorded by Bland-Sutton.[2] In a case which came under the notice of C. F. Rilot,[3] there was a hard circumscribed mass enveloping the roots of two mandibular molars. One molar had a septic pulp chamber and the general structure of the growth seemed to suggest that it was a case of inflammatory tissue which had partially ossified and calcified.

(7) COMPOSITE ODONTOMES

These odontomes consist of irregularly shaped calcified masses and are composed of enamel, dentine and cementum which are apparently disposed in no definite arrangement. They probably arise from an abnormal growth of all the elements of a tooth germ, namely, enamel organ, papilla and follicle. They may occur in

[1] Copied by permission from Wedl's "Atlas of the Pathology of the Teeth."
[2] "Tumours, Innocent and Malignant." Sixth Edition, p. 239.
[3] Reported by J. Murray, *Trans. Odonto. Soc.*, vol. xxxvii, p. 176.

either the maxilla or the mandible. They vary considerably in size and shape and in the arrangement of the tissues composing them. In one recorded by J. J. Andrew,[1] occurring in the right maxilla, the length was $1\frac{5}{8}$ in.; girth $4\frac{1}{2}$ in.; width, $1\frac{1}{4}$ in., and the weight was estimated at 500 gr. In the one shown in figs. 777 and 778,

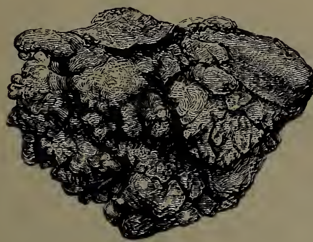

FIG. 777.[2]

recorded by Heath,[3] the measurements were $1\frac{1}{2}$ in. antero-posteriorly, 1 in. transversely, and $1\frac{1}{4}$ in. from above downwards; weight 315 gr.

According to Bland-Sutton the largest odontome known to have grown in the maxillary sinus is preserved in the museum of Guy's

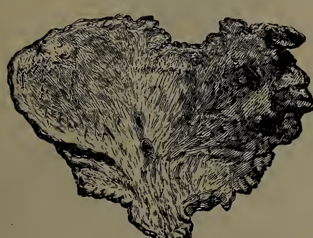

FIG. 778.[4]—Section of odontome shown in fig. 777.

Hospital (fig. 779). The clinical history of the case was recorded by Hilton[5] as follows:—

A man, aged 36, had a large osseous tumour occupying the antrum. The pressure of this tumour had caused the front wall of the antrum, with the integument and soft tissues covering it, to slough. The trouble was first noticed thirteen years before. As the cheek enlarged the eyeball became

[1] *Trans. Odonto. Soc.*, vol. xxvii, p. 42.

[2] From "Injuries and Diseases of the Jaws," by Christopher Heath.

[3] "Injuries and Diseases of the Jaws," by Christopher Heath. Fourth Edition, p. 319.

[4] From "Injuries and Diseases of the Jaws."

[5] *Guy's Hospital Reports*, 1836, vol. i, p. 493.

displaced and finally burst. For a long time the surface of the tumour was exposed, the suppuration being copious, and occasionally pieces of bone, irregular in shape, came away; at last, to the man's astonishment, the bony mass dropped out, leaving an enormous hole in his face.

FIG. 779.[1]

FIG. 780.[1]

The tumour weighed nearly 15 oz., and measured 27·5 cm. (11 in.) in its greatest circumference. This tumour presented, on section, an ivory-like surface, and on close scrutiny a number of

[1] From "Tumours, Innocent and Malignant," by Bland-Sutton.

closely arranged concentric laminæ (fig. 780). Sections ground thin and examined under the microscope showed large numbers of lacunæ and canaliculi arranged in a very regular manner.

A remarkable example of composite odontome is shown in fig. 781. It was removed from a Kaffir boy, aged 14, and occupied the

FIG. 781.[1] (Bland-Sutton.)

position of the left premolars and molars. In the mass, which is composed of dentine imperfectly calcified and very irregular, there seems to be some cementum but no enamel. The weight of the growth was 59 gm. or 885 gr., and the size 70 mm. by 62 mm. by

FIG. 782.[2]

39 mm. The parents first noticed a swelling when the boy was 6 months old, but they paid no attention to the growth.

Composite odontomes are rare among the lower animals.

In fig. 782 an illustration is given of a maxillary right central

[1] From "Tumours, Innocent and Malignant," by Bland-Sutton.
[2] From *Trans. Odonto. Soc.*

incisor, on the palatal aspect of which is a cauliflower-like mass of tooth tissue. This mass, although not an integral part of the root of the tooth, has nevertheless grown, as it were, around the root so that when the odontome is separated from the tooth a marked groove is seen on the former corresponding to the shape of the palatal surface of the root. An examination of the specimen shows that the odontome covered not only the root, but also the upper half of the palatal aspect of the crown of the tooth. The occlusal surface of the tooth shows no signs of attrition and therefore suggests that the tooth did not erupt into correct position; the root of the tooth shows signs of absorption around the apical portion. The fact that the root is fully formed and the odontome has grown around it seems to indicate that the formation of the odontome was subsequent to the growth of the root. A section of the specimen shows that it is composed of enamel, with cemental-like tissue; a few dentinal tubes are seen in places. The odontome must therefore be regarded as belonging to the composite class.

It is interesting to examine this specimen in the light of knowledge gained from others in order to determine whether such tumours are in any way related to supernumerary teeth. In the

Fig. 783.

first place we find, in the region of the premaxillæ, the ordinary supernumerary tooth appearing in the form of a peg-shaped or an irregularly shaped incisor.

Next, we have a stage, where in place of the single tooth, several well-formed denticles are present. Such a specimen has been figured and described by M. H. Cryer. In the region posterior to the maxillary left central incisor was a mass of tooth tissue composed of five separate denticles, each denticle being composed of enamel, dentine and cementum. Another specimen belonging to Cryer takes us a step further. Here a tumour had displaced the central incisor, the denticles contained in the tumour numbered thirty-five and were in some cases single and in others fused together. In a further stage, we have numerous denticles fused together so as to form an irregular mass of tooth tissue, and an excellent

example of this was figured by Bland-Sutton.[1] The tooth (fig. 783), removed from a lad, aged 19, was situated in front of the right first premolar and had caused displacement of the canine and lateral incisor. The root of the tooth was not formed and the crown showed nine distinct eminences. Bland-Sutton, in referring to this case, says that " the appearance of the specimen is as though a group of supernumerary teeth had become confluent "; also, " It is easy to imagine that if the cusps of this odontome had remained distinct and each had been separately erupted they would have been called supernumerary teeth. Indeed, many of the cusps can be easily detached from the main mass." On the other hand, if the denticles had remained separate and a cyst had developed in connection with them we should have the condition known as " compound follicular cyst." Thus " this strange specimen," to use Bland-Sutton's words, " serves to bridge the gap between compound follicular cysts and composite odontomes."

In the specimen shown in fig. 782, the stage of complexity seems to have advanced one step further, and in place of a tendency towards well-formed denticles we have more or less defined excrescences of enamel embedded, as it were, in a matrix of tissue cemental-like in character.

The odontome is not always the aberration of one tooth germ, for in some examples there is evidence of at least two teeth germs being implicated in the growth.

An idea of the microscopical character of some of these odontomes can be formed from figs. 784 to 787.

In figs. 784 and 785[2] the section is composed of alternate layers of enamel and dentine which are seen to run for the most part in a vertical direction. Here and there spaces exist, some being circular, others quite irregular in outline; the majority of these spaces are lined with enamel more or less perfectly calcified. Patches of enamel may also be seen dotted about the section. The arrangement of the structures in this loose fashion renders the tissue exceedingly friable.

In figs. 786 and 787[3] the structure is " complex and very mixed; in parts, labyrinthine or folded in appearance; in others, osteodentinal." The main body of this odontome was dentine, though of a very irregular character, full of openings and canals, with patches

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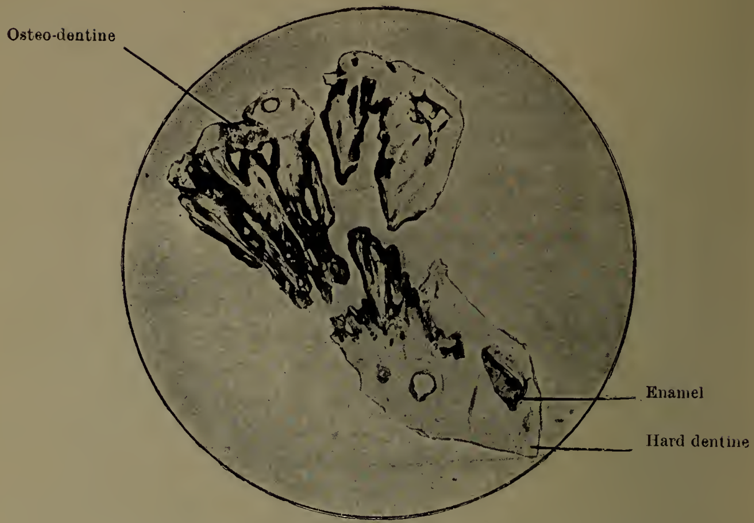
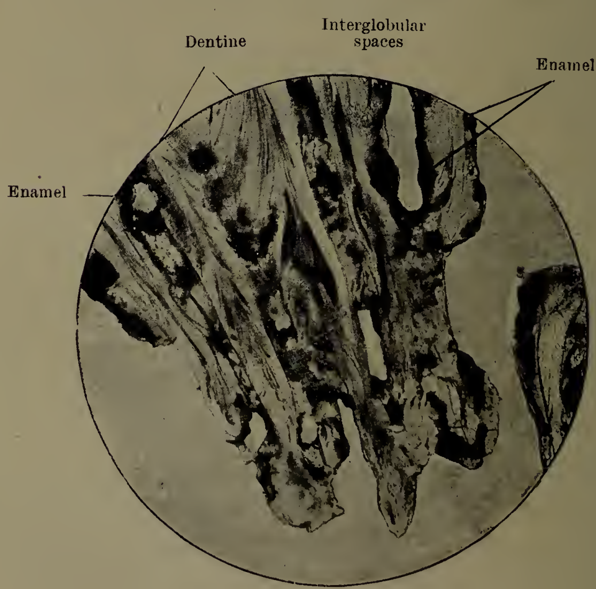
[1] *Dental Record*, vol. ix, p. 435.

[2] Recorded by J. Lewin Payne (*Brit. Dent. Journ.*, June 15, 1904, vol. xxv, p. 402).

[3] Recorded by J. J. Andrews (*Trans. Odonto. Soc.*, vol. xxvii, p. 42).



× 6.
Fig. 784.[1]



× 24.
Fig. 785.[1]

[1] From *Brit. Dent. Journ.*

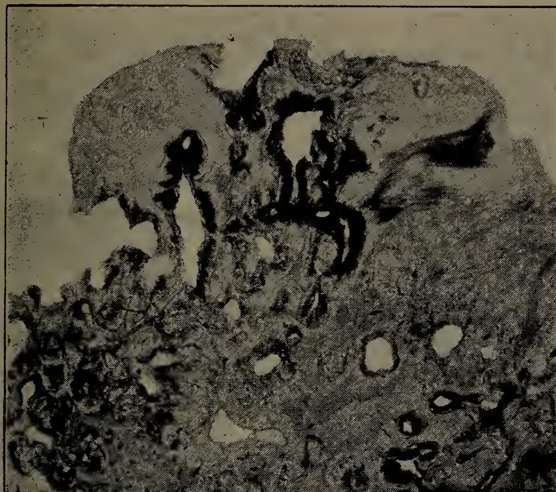


FIG. 786.[1]—Mag. 12 diam.

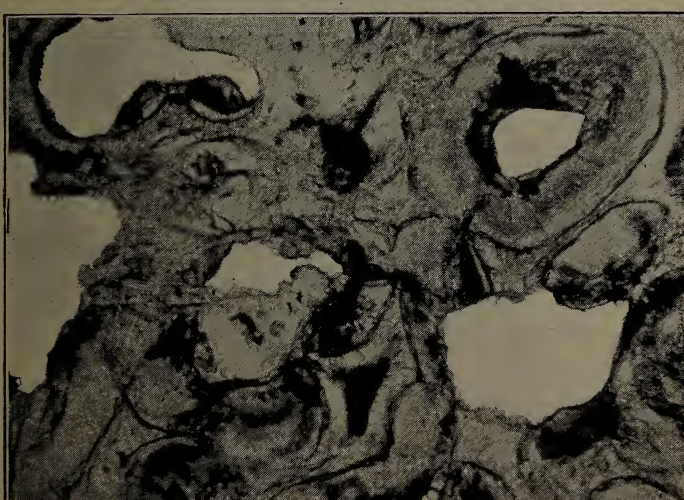


FIG. 787.[1]—Mag. 80 diam.

[1] From *Trans. Odonto. Soc.*

and crescents of enamel in all kinds of positions scattered through it. There was very little cementum, but a few lacunæ occurred in parts."

Signs and Symptoms.—An odontome is covered by a capsule from which it derives its nourishment, and, as it gives rise to no painful symptoms during the period of growth, its presence often passes unnoticed. Composite odontomes like teeth, are said to pass through an eruptive stage. The capsule is at some point destroyed and suppuration takes place, so that the odontome is likely to be mistaken for a more serious disease of the jaw.

Eve has described a group of tumours which he has classed as Composite Embryoplastic Odontomes. Clinically these tumours resemble sarcomata. Of the four cases he records three occurred in the mandible and one in the maxilla. The patients were aged

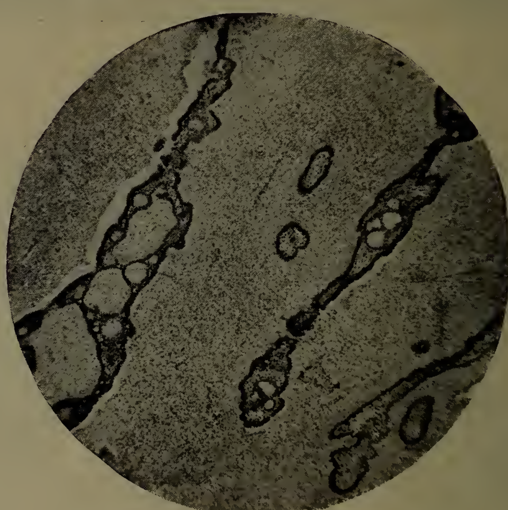


Fig. 788.—(Low power.) Composite embryoplastic odontome showing strands of enamel epithelium lying in a sarcomatous ground substance. The strands enclose small cysts and areas of stroma.

21, 33, 53 and 55 respectively when the tumours commenced. In one case the growth was of eleven years' duration, while in the one recorded in the maxilla the swelling had only been noticed for four months. Microscopically the tumours were composed of irregularly shaped masses and columns of enamel epithelium embedded in a sarcomatous stroma, figs. 788 and 789.

Eve[1] says: "the dental character of these tumours cannot be doubted, owing to the characteristic appearance and arrangement of the epithelium."

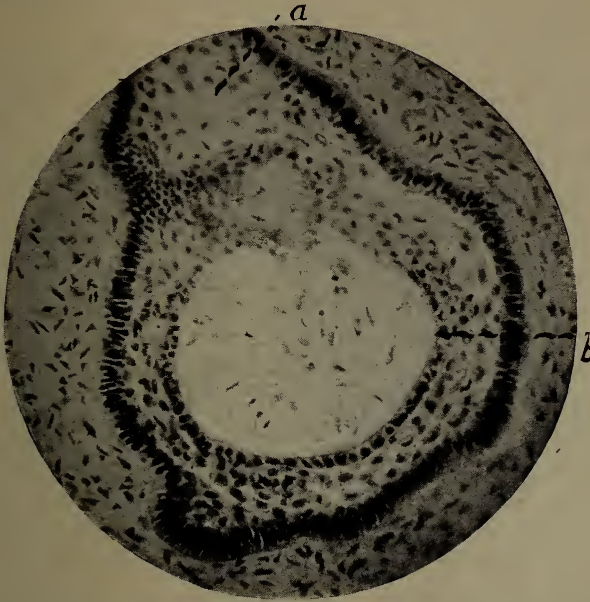


FIG. 789.—Part of section shown in fig. 788, but under a higher objective. The figure shows a rounded strand of enamel epithelium, lined externally with columnar cells. The intermediate layer exhibits a reticulum (*a*). At its centre the strand is penetrated by a round area of stroma (*b*).

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CHAPTER XXIII

The Treatment of Dental Disease in Children

In connection with the treatment of dental disease in children there are a few points which may conveniently be considered under a separate heading. No part of the work of the dental surgeon requires more tact than the treatment of children. Some possess the gift of readily winning the confidence of the young, but this power is not given to all. The operator must constantly bear in mind that he is dealing with children, and that they are interested only in simple topics. Every effort should be made to attract their attention and to avoid giving them pain; but if pain is unavoidable, in no circumstances should they be misled or deceived.

Too great a stress cannot be laid upon the importance of regular and thorough attention to the teeth of children. Dental supervision should commence as soon as the deciduous dentition is complete, and the child should be brought to the dental surgeon at least three times a year for examination. Cavities can then be filled while quite small, with the results that the teeth are more easily saved and the operation is rendered practically painless—a point of no small importance in dealing with children.

In treatment of dental disease in children **the importance of rendering the mouth functional** must be clearly kept in mind. If the mouth is rendered functional it will be kept clean by natural means. The chief causes of a functionless mouth in children are:—

(*a*) Mouth-breathing.

(*b*) Caries of the teeth.

(*a*) Mouth-breathing arising from nasal obstruction produces a persistent gingivitis of the gum in the front of the mouth, and predisposes the teeth to caries, especially the incisor teeth. Mouth-breathing is often overlooked, more particularly in children who suffer from intermittent nasal obstruction. *The sign of nasal obstruction which may be regarded as diagnostic consists in a marginal gingivitis limited to the incisor teeth, the gums at the back of the mouth being healthy.*

Too much importance cannot be attached to the proper performance of nasal breathing, and, if there is sufficient naso-pharyngeal

trouble present to cause even intermittent mouth-breathing, the trouble must be removed. *Unless a child regularly breathes through the nose it cannot have a healthy mouth.*

(*b*) Caries of the Teeth.—It is a matter of common experience that children with carious teeth "bolt their food," thus suspending the function of mastication. *Unless mastication is properly performed the mouth cannot be kept healthy.* It is essential therefore that children's teeth should be rendered capable of performing their function without the least discomfort.

Small cavities, whether in the crown or approximal surfaces, should be filled with amalgam, and special care should be taken to restore the contour of the tooth. (See p. 380.) Approximal cavities, when they have been opened up and the caries removed, are usually cup-shaped, and the retentive shaping must therefore be carried out by grooving. If the tooth is sensitive, it is sometimes judicious to bring the filling of amalgam against the approximal tooth. With children it is sometimes impossible to remove all the carious dentine in the deeper parts of the cavity. Under these conditions the surface of the dentine should be covered with a little powdered nitrate of silver before the filling is inserted.

If the pulp of a tooth is exposed, the better line of treatment, in the majority of cases, is to remove the tooth. This practice may not coincide with that of the majority of practitioners, but the impossibility of thoroughly treating pulp chambers in children, and the fact that suppuration frequently occurs after treatment incline me to the opinion that, by extraction, the mouth is more likely to be rendered functional. The only instances where conservative treatment is indicated are cases of second deciduous molars in children under the age of six years, that is, where the first permanent molars have not erupted; but even in these cases, the teeth should be carefully watched, and, if periodontitis appears, they should be removed.

If it be decided to retain the tooth, the pulp should be removed from the coronal portion of the pulp cavity, and, if possible, from the root canals. Sterilization should then be carried out and the pulp chamber filled with iodoform or loretin. No attempt should be made to fill the canals, the cavity in the tooth being completed with amalgam.

In a child a tooth with a septic pulp chamber often causes no objective symptoms, but yet is the seat of a slight chronic periodontitis; moreover, the constant absorption of the septic matter from the pulp chamber is liable to cause chronic lymphadenitis.

The cases, however, which demand most serious consideration

are those where the majority of the deciduous molars are carious and absolutely unsavable and the child suffers from the effects of sepsis. If the first permanent molars are in position, the best treatment seems to be to remove all the deciduous molars. This treatment has the advantage of removing all sources of sepsis and of isolating the first permanent molar—a point of the greatest importance when the value of this tooth in mastication is considered. As a rule, all opposing teeth, even if free from caries, should be removed. The necessity for removing all opposing teeth will perhaps be made more clear by giving an example. Suppose that the right maxillary deciduous molars and the left mandibular molars are unsavable and are removed, then the opposing teeth, namely, the right mandibular and the left maxillary molars, are rendered functionless and are of little use, indeed as functionless teeth they will harbour food débris and so prevent the mouth from being kept naturally clean. The removal of all non-functional deciduous teeth is therefore called for, if the mouth of a child is to be kept clean and healthy.

An objection has been raised that this method of treatment robs the child of masticating power. In answer to this objection it may be pointed out that a carious tooth is usually tender and is avoided in the process of mastication, and that where many carious teeth are present no attempt is made to masticate, the child "bolting" its food. The first permanent molars in many of these children are thereby rendered functionless and this can be easily demonstrated by the amount of débris which is present around these teeth. The removal of the carious deciduous teeth allows mastication to be efficiently performed and the masticating power is increased rather than diminished. Another argument advanced against this treatment is that the removal of the deciduous molars allows the first permanent molars to come forward and so cause, in the future, crowding of the anterior teeth. With regard to this argument, it may be pointed out that such travelling forward of the permanent teeth occurs mainly in mouths in which the growth of the jaws is hindered by want of function arising from insufficient mastication or from lack of nasal breathing. From observation—but the point is one on which final judgment is reserved—I am inclined to think that if by removing the deciduous molars the first molars can be rendered functional, the growth of the jaw will be stimulated, and room will be made for the development of the second and third molars. With no forward pressure from the second and third molars, and with the first molars occluding correctly, there will be little, if any, forward movement. But, granting that the suggested treatment by extraction does cause a forward movement and subsequent crowd-

ing, the removal of four teeth will easily alleviate the condition. A decision has to be made between the disadvantage arising from the possible loss of four teeth on the one hand and the constant presence of oral sepsis and all the sequelæ on the other. In my opinion the risk of sepsis is by far the greater evil. Still further, it must always be remembered that even if the deciduous molars are retained with the object of preventing a forward movement of the molars, it is quite possible that the removal of teeth to prevent crowding would be necessary, as in mouths such as these in question some interference with the development of the jaws would probably have taken place.

Cases are frequently seen in which caries has progressed rapidly in the first permanent molars to the extent of involving the pulp cavities before the formation of the roots is complete. Such teeth should be removed for they cannot be satisfactorily treated by conservative operations and if left untreated become the foci of infection.

A detailed account of a few cases will serve to illustrate the value of this method of treatment where a child is suffering from dental sepsis.

A., female, aged 4 years 6 months, when first seen was suffering from gastro-intestinal trouble.

Teeth removed: $\begin{array}{r|l} \text{d c b a} & \text{a b c d} \\ \hline \text{e d}\quad\quad\; & \quad\quad\;\text{d e} \end{array}$

The $\underline{\text{e}|\text{e}}$ were not carious and were retained until the $\underline{6|6}$ erupted. The gastro-intestinal trouble cleared up and within four months the child increased in weight from 2st. 4lb. to 2st. 8lb. The normal weight should have been about 2st. 8lb., and the normal increase in four months about 1½lb.

The rapid increase in weight which follows the extraction is at times very marked. For example, in the case of a boy, aged 10 years 2 months, who was suffering from "glands," it was found advisable to remove $\begin{array}{r|l} \text{e d c} & \text{c d e} \\ \hline \text{e}\;\;\;\text{c} & \text{c d e} \end{array}$

In four months his weight increased 5lb., viz., from 4st. 6lb. to 4st. 11lb. The normal weight should have been about 4st. 11½lb., and the normal increase in four months about 2lb.

The following case also illustrates the marked improvement in weight which follows the removal of septic teeth: A boy, aged 6 years 6 months, suffering from marked oral sepsis, enlarged glands in the neck, and gastro-intestinal trouble, was seen on November 28. He was weak and debilitated in appearance, with dark rings under his eyes. He weighed 2st. 12lb. The following teeth were removed: $\begin{array}{r|l} \text{d}\;\;\;\text{b a} & \text{a b}\;\;\;\text{d} \\ \hline \text{e d}\;\;\;\text{b a} & \text{a b}\;\;\;\text{d e} \end{array}$

The first permanent molars had just pierced the gum, and the

e | e, the pulps of which were not exposed or septic, were retained until the 6 6 had completely erupted. He was seen again seven weeks later, when his weight was 3st. 3½lb., or a gain of 5½lb. in about seven weeks. The glands of the neck were considerably smaller, he had lost the dark rings under his eyes, and his appetite and general health had increasingly improved.

A boy, aged 7 years 4 months, stated always to have indigestion. The following teeth were removed: $\frac{6\,e\,d\,c \mid c\,d\,e\,6}{6\,e\,d\,3 \mid c\,d\,e\,6}$. His weight was 3st. 2½lb. Two months later, his weight had increased by 2½lb. to 3st. 5lb., and all symptoms of gastro-intestinal trouble had ceased. The average weight of a boy of this age would be about 3st. 9½lb., and the increase in two months only a little under 1lb.

Increase in weight after extraction does not always occur, and in a few cases there is a slight reduction in weight, but this is frequently traceable to the presence of sepsis in other parts, for example, in the tonsils or the naso-pharynx, as shown by the following case: A child aged 7 years 6 months suffering from defective teeth, tonsils and adenoids, was seen on February 23, when the following teeth were removed: $\frac{6\,e\,d\,c \mid c\,d\,e\,6}{6\,e\,d \mid d\,e\,6}$

The tonsils and adenoids were removed on May 3. The child's weights are given below:

	St.	lb.	oz.
February 23	3	10	8
March 24	3	9	12
May 25	3	9	12
July 26	3	10	12
October 15	4	0	6

Here the improvement in weight and general health did not follow extraction until other sources of sepsis had been removed.

The cases quoted afford sufficient evidence that the loss of masticating power does not interfere with the general health of a child, but increases its powers of metabolism by removing a source of sepsis.

The effect of early removal of the teeth on the dental arches is shown in the three following cases:—

The models shown in fig. 790 are from the mouth of a child from whom, at the age of 4 years, all the deciduous teeth were removed with the exception of the upper canines.

In the case shown in fig. 791 the deciduous molars were removed at the age of 8. The eruption of the premolars caused a slightly crowded condition which was remedied by the extraction of the second premolars. There is here no evidence that a crowded arrangement of the teeth would have been avoided by the retention

of the deciduous molars; a line of treatment which produced a clean mouth for four years with, admittedly, some risk of crowding, which is not however difficult to remedy, seems strongly to commend itself as against a septic mouth and possibly the avoidance of crowding.

An example of a case in which the first permanent molars and the deciduous molars were removed at the age of nine years is shown in fig. 792.

Occasionally, extraction on these lines does not produce the desired results, but the failure in these cases is often to be traced to

Fig. 790.[1]

Fig. 791.[1]

asymmetrical extraction rather than to the particular line of treatment.

Where the deciduous teeth are decaying on all surfaces—a condition not infrequently arising from the sucking of sugar bags or the constant presence of an easily fermentable carbohydrate on the surfaces of the teeth—a considerable improvement can be affected by careful regulation of the diet and regular cleansing of the teeth, combined with local treatment of the teeth. For local treatment no drug is more efficacious than nitrate of silver, which should be applied to all the carious surfaces of the teeth. To apply the drug, a small portion should be melted on the end of a steel

[1] From *Royal Dental Hospital Reports.*

instrument so as to form a small bead which can be applied at any point with accuracy and safety. About four applications should be made at intervals of about a week, and afterwards regularly at intervals of three months. Once a day spirits of wine should be applied to the teeth as follows: The surfaces of the teeth should be thoroughly dried, the spirit applied on cotton-wool, and the saliva kept away, if possible, for one or two minutes. The spirit, in evaporating, dehydrates the dentine and apparently hardens the

Fig. 702.[1]

surface. Twice a day, morning and evening, an alkaline mouth-wash should be used. If these directions are faithfully carried out, the teeth can often be retained for the normal period. Nitrate of silver must be applied with caution. On no account should it be held between the blades of conveying forceps, as it may slip from them and pass either into the larynx (as is known to have happened

[1] From *Royal Dental Hospital Reports*.

in one case), or into the stomach. If nitrate of silver passes into the larynx, inversion might be tried, but skilled surgical aid should immediately be sought; if it passes into the stomach, a plentiful supply of common salt should be given in order to create a chemical reaction leading to the formation of the insoluble and inert chloride of silver.

The practitioner should impress on parents the necessity of keeping the first permanent molars scrupulously clean during eruption, and explain to them that these teeth form the vanguard of the second dentition and that during the period of eruption the destructive agents are most active, the loose flap of gum overlying the crown acting as a food-trap.

As soon as the first permanent molar shows signs of caries in the fissures on the occluding surface, the fissures should be cut out and filled with amalgam.

The removal of the deciduous teeth by extraction is dealt with in chapter XXVII.

CHAPTER XXIV

Odontalgia and Neuralgia

Pain arising in connection with disease of the teeth is usually designated by the term "Odontalgia."

Pain from visceral disease may be:—

(1) Local, i.e., located in the part diseased.

(2) Referred to the terminations of some nerve trunk implicated in the disease; or

(3) "Painful impressions may be conducted up the sensory fibres of the sympathetic into the central nervous system, and then referred to the peripheral distribution on the surface of the body of these nerve fibres that enter the same segment. This is true visceral reflected pain" (Head).

Pain from a tooth, therefore, may be localized to the tooth, referred to another part—for example, the temporal region—or associated with a painful area in the skin. It would seem, however, better to restrict the term "odontalgia" to pain definitely referred to a tooth or teeth and to consider all cases in which the pain is referred to other parts as "neuralgia."

ODONTALGIA

Odontalgia may be divided into:—

(*a*) *Local.*

(*b*) *Referred.*

By "local odontalgia" is meant pain in or around teeth which are themselves the cause of the trouble; by "referred odontalgia" is connoted pain in a tooth which is not itself the seat of the cause.

(A) LOCAL ODONTALGIA

Nearly all morbid conditions of the teeth may be cited as causes of local odontalgia. For convenience they will be grouped under:—

(*a*) Morbid conditions of the periodontal membrane.

(*b*) Morbid conditions of the pulp.

The principal affections under the first head are acute and chronic periodontitis and their sequelæ, and under the second, acute and chronic pulpitis.

Local odontalgia may be acute or chronic, and for practical purposes the source of the pain may be regarded as either the pulp or the periodontal membrane.

(1) **Acute local odontalgia** is generally due either to acute pulpitis or to acute periodontitis. *If due to pulpitis*, the pain will be of a sharp, shooting, throbbing character, more severe when the patient assumes the horizontal position, and greater at night than in the morning. Paroxysms of pain will also be caused by alternations of temperature. A small pledget of cotton-wool placed in the cavity and gently pressed upon with a blunt instrument will generally produce pain, as in this form of odontalgia the pulp is usually exposed. In a few cases, the application of cold brings relief, while heat intensifies the pain. A condition of this character points to a suppurating pulpitis, the cold constricting the arteries and so reducing the blood-pressure, the heat dilating the vessels and therefore increasing it. A sharp, shooting pain, associated with marked tenderness of the tooth to pressure, usually implies tension in the pulp chamber from a putrescent pulp.

If periodontal inflammation is the cause, the pain will be of a dull, gnawing, constant character. Percussion of the tooth with an instrument will generally cause pain. (Where pain arises in connection with the pulp, percussion does not as a rule cause pain.) Pressure with the finger upon the crown of the tooth will also produce pain, and the alveolar process is usually tender. A pledget of cotton-wool introduced into the cavity, if one exists, will not give rise to any pain except that which is caused by the pressure transmitted to the periodontal membrane. Alternation of temperature from hot and cold fluids may affect the pain, but not to the same extent as in pulpitis. By limiting the heat or cold to the tooth, the source of pain can be easily diagnosed. With periodontitis, pain will not be felt.

The *treatment of acute local odontalgia* depends upon the cause. The remedy for each morbid condition has already been dealt with in previous chapters. Temporary relief of the pain in cases of pulp trouble may be obtained by applying to the cavity, on a piece of cotton-wool, some sedative, such as oil of cloves, oil of peppermint, or carbolic acid, covering over the drug with some loose dressing, such as cotton-wool dipped in gum sandarac or mastic. Periodontal pain can generally be relieved by the application of tincture of iodine, to which some tincture of aconite may be added. When the pain is due to tension in the pulp cavity from the putrescent pulp, relief can be obtained by opening the pulp chamber and so giving exit to its contents.

(2) Chronic Local Odontalgia.—The *causes*, like those of the acute form, may either be connected with the pulp or with the periodontal membrane. *The symptoms arising from the pulp* will be pain at irregular intervals, but less intense than in the acute form, and a tendency for the pain to wander and follow the course of the nerve.

Alternations of temperature, or the application of irritant food substances, such as sweets, sours, &c., generally produce a paroxysm of pain which may pass away at once or continue for some time. When the odontalgia arises *from the periodontal membrane*, the patient will complain of a grumbling sensation in the tooth and tenderness on pressure. The gum over the alveolar process will be slightly swollen, congested, and tender to pressure. The pain is usually constant, not paroxysmal, like the pain arising from pulp trouble, but it may be affected by alternations of temperature. A frequent cause of local odontalgia, and one that is often overlooked, is absorption of the septa between the teeth in chronic periodontitis. Food collects in the space formed, and pain results owing to pulp irritation via the cemental tissue or by infection via the periodontal membrane.

The *treatment*, as in the acute form, depends upon the cause.

(B) REFERRED ODONTALGIA

Referred odontalgia may arise from many causes.

Any conditions which give rise to irritation of the terminal portions of the fifth nerve and its connections may cause reflex odontalgia, and by far the commonest condition which comes under this heading is that which is *dental in origin*, i.e., where the cause lies in a tooth which is not itself the seat of pain. Such cases are of frequent occurrence. A patient complains of pain, say, in a mandibular molar, which, on examination, is found to be free from disease, the cause eventually being discovered in, perhaps, a maxillary tooth. This condition, generally called "referred toothache," is at times so pronounced that manipulation of the offending tooth will cause paroxysms of pain in the sound tooth, and in one case within the author's recollection the application of arsenic to the pulp caused pain in the sound tooth during the process of devitalization. Pain may be referred from a maxillary to a mandibular tooth, or the reverse; it may also be referred from one tooth to another on the same side of the same jaw. Perhaps the most common and most instructive example of referred pain is that of a mandibular third molar causing symptoms in a mandibular pre-

molar. Pain is never referred across the median line of the mouth. *Morbid conditions of the periosteum of the jaws, and ulcerations of the mucous membrane*, &c., may act as causes of odontalgia, and likewise *operations upon or morbid conditions of the eye and nose*. Cases supporting the latter statement are quoted by Galezowski and Macnaughton-Jones.

Toothache is frequently met with in patients with uterine troubles; in those with disorders of the alimentary tract, and in those who are the subjects of malaria, gout, rheumatism, and syphilis. The probable explanation is that the blood is charged with toxic matter, and slight lesions of the teeth cause pain which would not be felt under ordinary conditions.

The diagnosis of referred odontalgia cannot always be readily arrived at. If no local cause can be found for pain which is referred by a patient to a tooth or teeth, a systematic examination of all the teeth must be carried out. As this examination is practically similar to the method to be pursued for investigating cases of neuralgia, it will be considered under that heading.

NEURALGIA

Neuralgia is a term used to denote pain in the course of the nerve, or within the area of its distribution. When pain occurs in connection with the fifth nerve, it is known as trigeminal or trifacial neuralgia. It is not itself a disease, but only a symptom of organic and functional disease. To this statement, however, an exception must probably be made in the case of "epileptiform neuralgia," which is held by some to be a definite affection of the nervous system.

Many different conditions are described under the name neuralgia, and these Head divides into:—

(A) Neuralgia quinti major (tic douloureux, epileptiform neuralgia).

(B) Neuralgia secondary to disease of the nerves of the head, for example, tumours involving the fifth nerve.

(C) Neuralgia minor.

(*a*) Visceral referred pains due to disease of the intimate structure of some organ of the head.

(*b*) True neuralgia minor.

(D) Neuralgia secondary to general disease, such as anæmia, hysteria, malaria, &c.

(A) Neuralgia major is considered by some authorities to be a definite disease of the nervous system with a distinct course and

character. A most excellent descriptive account of this disease is to be found in Head's article on trigeminal neuralgia (Allbutt's "System of Medicine," vol. vi, p. 724). The disease is of importance to the dental practitioner, as many of these cases come under his notice in their early stages. In the early stage, the disease simulates a simple neuralgia, flashes of pain starting from one or more foci. The paroxysms increase in severity and duration, until they become almost unbearable. When the disease is fully developed, the paroxysms of pain are distressing to the onlooker. On the side of the head and face affected there are "alternate flushes and pales, and the muscles are in violent spasm, the skin sweats profusely, and the mouth and eye pour out saliva and tears. At the height of an attack the pulse fails, and the patient becomes almost unconscious from pain and shock. The paroxysms are started by a stimulus of any degree or kind applied to the sensory area to which the pain is referred, or may be quite spontaneous."

The Gasserian ganglion would seem to be the starting point of these impulses, because the removal of the ganglion cures the disease. There is, at present, no known microscopical method which will enable a normal Gasserian ganglion to be distinguished from one removed from a patient affected with neuralgia major.

In an admirable paper on this disease, R. Rollinson-Whitaker[1] states that the disease, when at all severe, is never seen in patients who do not also show signs of arterio-sclerosis, and he inclines to the view that in about 90 per cent. of the cases the exciting cause lies in the mouth. In patients with chronic sepsis, he thinks "a steady stream of afferent impulses ascends, so slight that they are not noticed save when something causes an extra outburst; and these, so to speak, try the patience of a long-suffering Gasserian ganglion to such an extent that all that is needed to cause it to burst into paroxysms of pain some day is a new and severe pain stimulus—maybe of very short duration—or even the general constitutional depression which any acute intercurrent disease may so readily cause."

It would be idle to deny the force of this author's argument with regard to the possibility of sepsis in the mouth acting as the cause, on the ground that in many of these cases the teeth are sound. In recent years our views as to what a sound tooth really is have changed. A tooth, although quite free from caries, may be the seat of a chronic periodontitis, and it is this type of tooth

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[1] "Concerning Cranial Neuralgias," *Brit. Dent. Journ.*, vol. xxx, p. 193.

which is so frequently regarded by the medical practitioner as normal. Nor is it reasonable to assume that the teeth cannot have caused the disease, because their removal fails to effect a cure. It is quite feasible that, before their removal, and owing to their presence, the seeds of a disease may have been sown which may subsequently fructify as the result of pain stimulus.

Victor Horsley[1] states that he has seen cases of peripheral origin where the neuralgia had arisen from an ascending neuritis traceable to chronic osteitis of the tooth sockets.

(B) Neuralgia due to organic disease of the fifth nerve is difficult to distinguish from the pain of neuralgia major. The pain may be intense and radiate over the area supplied by the nerve, or it may be local, although paroxysmal and active in character. In differentiating between this type of neuralgia and neuralgia major, it must be observed whether the pain is "usually accompanied by a marked loss of sensation over the area to which the affected branch is distributed."

(C) Neuralgia Minor.—(*a*) **Visceral Referred Pain.**—The reason for cutaneous tenderness in visceral disease is explained by Head as follows:—

"When impulses pass up sensory sympathetic nerves from an organ which is diseased they set up a disturbance in the segment to which they are conducted. Now any second sensory impulse from another part, e.g., from the surface of the body which passes into this same segment, will be profoundly altered, for it no longer falls into a normal and quiescent segment of the nervous system, but into one whose activity is already disturbed. The resultant stimulus, conducted upwards towards the brain, therefore differs from that which would have passed inwards from that segment under normal circumstances. The second stimulus will appear to be exaggerated, or may perhaps undergo some actual increase in its passage through the excited segment."

"Thus any otherwise painless stimulation applied to the surface of the body falling within the area supplied by fibres that enter the disturbed segment, will appear to be painful, and the skin will be said to be tender."

"In the head, these areas are supposed to represent the segmental origin of the nerves for pain, heat, and cold."

The exact relationship of each tooth to the segmental areas seems to vary. The following table is given as approximate:—

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[1] *Brit. Med. Journ.*, September 9, 1905, p. 556.

Maxilla.		Mandible.	
Incisors	Fronto-nasal.	Incisors	Mental.
Canine	Naso-labial.	Canine	,,
Premolar I.	,,	Premolar I. ...	,,
,, II.	Temporal or maxillary.	,, II. ...	Doubtful.
Molar I.	Maxillary.	Molar I.	Hyoid.
,, II.	Mandibular.	,, II.	,,
,, III.	,,	,, III.	Superior laryngeal or hyoid.

The diagrams (fig. 793) show these areas, and the maxima points of these areas.

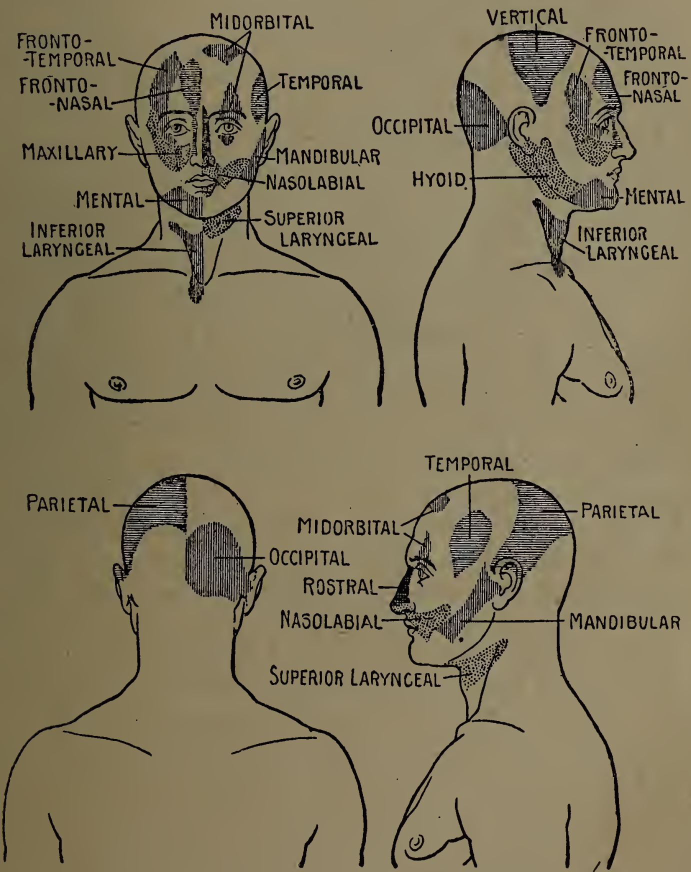

Fig. 793.[1]

The method of testing for the superficial tenderness is by means of the blunt end of a pin. To the normal skin the touch feels blunt,

[1] From Allbutt's "System of Medicine."

but when the skin is sensitive the patient complains that the touch hurts, and that the part is tender, or he may fancy that he is being pricked. The tender area over the hairy scalp may be defined by gently pulling the hair, while with skin which overlies soft structures, such as the neck, gentle pulling between the fingers is advised.

Head's observations are interesting, but further investigations are required before their practical value in diagnosis can be definitely determined. The "segmental" areas are not to be confounded with so-called "foci" of pain observable in certain neuralgias.

It must be clearly kept in mind that the "segmental" areas do not correspond to the distribution of the peripheral branches of the cranial nerves, and the maxima points do not correspond to the so-called "foci" of pain experienced in certain neuralgias.

(*b*) **True Neuralgia Minor.**—In this form of the disease the pain is "neuralgic" in character, is of a darting, shooting type, and closely resembles neuralgia major. Usually there is no superficial tenderness; *but when tenderness is present, the sensitive area corresponds to the peripheral distribution of the affected nerve trunk.*

Causes.—Any disease to which the teeth are liable is to be regarded as a cause of **neuralgia minor.** The most frequent causes are chronic inflammation of the pulp and chronic periodontitis starting at the gingival margin. General conditions which lower the resistance of the tissues, such as fatigue, rheumatism, and anæmia, increase the intensity of the attacks of pain.

Diagnosis.—The diagnosis of the cause of facial neuralgia is important because the treatment must depend on the cause, and all cases which come under notice should be subjected to a systematic examination. The patient should be questioned as to the character of the pain, in order to discover whether the pain arises from the pulp or from the periosteum. It is also important to ascertain if the pain is periodic, while at the same time the knowledge of its situation is useful in assisting to localize the position of the tooth should the neuralgia be of dental origin. Thus, pain in the infra-orbital or supra-orbital region points to maxillary teeth: pain in the ear, shooting down the shoulder, points to mandibular teeth; while pain over the parietal eminence indicates trouble from either maxillary or mandibular teeth. Next, the teeth must be examined for carious cavities, and, should any be found, a search should be instituted to discover if any chronically inflamed pulps exist. This examination should be carried out with a mirror and a probe, care being taken to look for approximal cavities near the gum margin.

After this, periodontal causes should be excluded by pressing and tapping the teeth and carefully examining the "pockets" around the teeth. Irritability of the pulp through pathological changes must next be eliminated by looking for exposed surfaces of dentine or cementum. Exposure of the root in chronic local periodontitis is a fruitful cause of neuralgia (see p. 499). Each tooth should next be tested with heat and cold, and, in doing this, attention should be bestowed upon teeth containing large metal fillings. In testing with heat, a ball of base-plate gutta-percha should be made hot and applied to each tooth separately; while the test with cold is easily carried out by touching each tooth with a small pledget of cotton-wool dipped in ice-cold water, or spraying with ethyl chloride. If a jet of cold water is used from a syringe, the water will run over two or three teeth at a time, and so prevent ready detection of the offending tooth. It must not be overlooked that most teeth with live pulps, if submitted to the above treatment, will respond to the changes; but when the pulps are healthy, the condition will be quite transient, while, if diseased, the test will probably set up an acute paroxysm of pain. In cases of doubt the neighbouring teeth should be tested as well as the suspected tooth. The pain started in the affected tooth will be greater in comparison with that in the approximal teeth. Suppurative conditions of the periodontal membrane are to be regarded as frequent causes of trigeminal pain. The exposure of the roots leads to irritability of the pulps from thermal and other irritations, while in advanced conditions the pulps may be affected via the apical foramen by spread of inflammation from the periodontal membrane.

If a cause has not been discovered by the above-mentioned examination, the absence of third molar teeth, a frequent cause of neuralgia in those between 18 and 30, should be considered. Such causes as morbid conditions of the periosteum of the bony canals through which the nerve passes, the peripheral irritation in other parts of the distribution of the fifth nerve, must next be excluded. Failing these, the presence of antral mischief or tumours in the region of the trunk of the nerve should be looked for, and then the question of organic disease in the brain and neuralgia major should be considered.

Treatment.—If the neuralgia is dental in origin, the cause must be removed by the measures indicated for the treatment of such lesions. When the cause is constitutional, remedies appropriate to the condition must be adopted. For instance, if arising in connection with general debility, anæmia, or overwork, a general tonic treatment with such drugs as iron, quinine, and arsenic will

be beneficial, careful attention being paid to the condition of the bowels. Phenacetin, one of the antipyrin group (10 to 15 gr.), is useful in neuralgias of peripheral origin. If of malarial origin, quinine in large doses, i.e., 5 to 10 gr., will bring immediate relief, and if given before an attack will, in some cases, ward it off, and, in others, greatly minimize its severity. Should there be any suspicion of syphilis, iodide of potassium would be indicated; while with gout and rheumatism the same drug may prove useful. In addition to the internal administration of drugs, local applications may be tried, such as chloral and camphor in equal parts, aconite and chloroform, or counter-irritants, such as cantharides, capsicum, and mustard. If no cause can be found, and the above treatments fail, the drugs which may be termed "neuralgic specifics" should be tried, amongst these being tinct. gelsemii, veratrina, butyl chloral hydras. In combination with these, such drugs as dilute hydrobromic acid, chloral and bromide of potassium may be given. In more severe cases, the injection of morphia may be resorted to.

In cases where treatment by drugs fails and the patient continues in great pain, injections of alcohol may be tried, and failing relief from these, surgical methods may be adopted. These questions belong to the domain of general rather than dental surgery.

The following articles will repay perusal:—

Head, H. "Trigeminal Neuralgia," Allbutt's "System of Medicine," vol. vi, p. 724.

Rollinson-Whitaker, Ray H. "Concerning Cranial Neuralgias," *Brit. Dent. Journ.*, vol. xxx, p. 193.

"Discussion on Neuralgia," Dental Section, British Medical Association, September 9, 1905, p. 546.

CHAPTER XXV

Diseases arising from Sepsis in connection with the Teeth

General Considerations—Affections of the Mouth and Associated Parts—Affections of the Respiratory Tract—Gastro-intestinal Affections—General Conditions arising from the Absorption of Abnormal Oro-gastro-intestinal Products—General Conclusions.

In the preceding chapters the various pathological processes arising in connection with the teeth have been considered and it has been shown that septic and infective conditions are associated with many of these processes. These processes or conditions are now commonly grouped under the term "oral sepsis." It is necessary, therefore, for the student to bear in mind that the term "sepsis" is used in a broad sense, and includes infective as well as septic processes.

In recent years there has been an increasing tendency to recognize the mouth as a focus of infection, and it has been conclusively demonstrated that many obscure pathological conditions are wholly or in part due to absorption of toxins and organisms from mucous surfaces and that the most important source of infection is the gastro-intestinal tract. Although the intestinal tract may unquestionably become infected and inflamed without any apparent "oral sepsis," it is obvious that, with sepsis in the mouth, the probability of infection in the intestinal tract is greatly increased. It is, therefore, the primary duty of the dental practitioner to assure himself that the mouth is kept as aseptic as possible, and he should hesitate to undertake any operation which is likely to produce sepsis.

(A) GENERAL CONSIDERATIONS

It is generally admitted that periodontal disease may be the starting point of conditions which lead to various other pathological lesions and it is proposed, therefore, to review this subject broadly, and to make special reference to certain diseases which seem to be frequently traceable to mouth infection. A full and detailed discussion of the subject would involve a deep incursion into the realms

of general pathology and is therefore beyond the scope of the present work.

(i) The Normal Conditions of the Alimentary Canal

In the normal mouth the teeth are arranged in a regular arch; the gums are firm and of a light pink colour and are attached to the teeth at their necks. In the process of mastication particles of food tend to cling about the teeth, especially around the necks of the teeth where the gingival margin is attached in such a way as to leave a slight trough, but, when normal conditions prevail, the mouth is quickly freed of food débris by the combined action of the cheeks, tongue and saliva.

In the healthy mouth certain organisms are always present. The majority of these organisms cannot be grown in ordinary culture media, and, of those which can be grown, the streptococci are in "overwhelming preponderance." When food is being taken, and probably at other times, adventitious organsims are introduced into the oral cavity.

Various factors contribute towards the maintenance of the "bacteriological balance" in the mouth, e.g., (1) the mouth is constantly flushed with saliva which carries the organisms to the stomach; (2) phagocytes are incessantly passing up between the epithelial cells and either take up the organisms or discharge their bactericidal content; some, "having performed their functions, undergo dissolution or are swept away by the currents of saliva," while others find their way back into the subjacent tissues and are rapidly destroyed; (3) the bacterial struggle for existence is probably a contributory factor.

The organisms reaching the stomach from the mouth are mostly killed or inhibited by the action of the gastric juice, and a few hours after meals the duodenum may be found quite sterile. In the small intestine bacterial growth starts afresh, the rate of growth increasing as the colon is approached; at the colon bacterial multiplication reaches its maximum. The bile exercises a selective action on the organisms, and, while checking the growth of certain organisms such as the delicate streptococci, the pneumococci and the Bacillus proteus, it has no effect on the typical intestinal bacteria such as the B. coli group and the hardier streptococci. The bacteria in the intestines are disposed of in two ways. Some are expelled with the fæces, and these are probably in the majority; while others find a passage through the intestinal wall. The latter are either arrested in the subcutaneous lymph nodules, or, evading these, are either trapped in the mesenteric and retro-

peritoneal lymph glands, or reach the venous radicles of the portal vein where the endothelial cells arrest the leucocytes with the contained bacteria.

With regard to the toxic products of the bacteria, it is, says Andrewes,[1] "conjectured that such injurious substances absorbed from the alimentary canal as may escape the alchemy of the liver are neutralized by the secretion of certain of the ductless glands—for example, the thyroid."

Briefly, it may be said that under normal conditions the organisms in the alimentary canal are efficiently dealt with by the body defences and their presence causes no ill-effects.

(ii) Abnormal Conditions of the Alimentary Canal

Any septic condition of the mouth adds fresh organisms, the normal flora being increased and new varieties appearing. "The abnormal products of tissue reaction to injury are present, that is, inflammatory exudation which is rich in proteid, and an enormous increase of dead cells, epithelial and otherwise." The abnormal flora in conjunction with abnormal environment modify the virulence of the organisms in the direction either of attenuation or of exaltation.

The local effect of this increase of organisms is to undermine and weaken the epithelial covering, which then affords a passage for the organisms into the deeper tissues, and, in periodontal disease, where the organisms and their product are stagnant in the "pockets," the organisms constantly pass into the medulla of the bone and are absorbed into the general circulation. This latter condition is manifestly present where there is marked rarefying osteitis, and is probably also present in many cases where there is little bone destruction.

The presence of an increased number of organisms and their toxins in the stomach generally results in a gastritis, which in its turn lessens the efficiency of the gastric defence, and an overwhelming number of organisms pass into the small intestines. Under these conditions the defences of the intestines are taxed to their uttermost and a greater number of organisms pass from the intestinal surface into the system. In the opinion of Adami, this condition often leads to a sub-infection rather than an active infection. "The bacteria carried in do not multiply and set up foci of suppuration; they are destroyed, but with their destruction the

[1] "Discussion on Alimentary Toxæmia," *Proc. Roy. Soc. Med.*, vol. vi, No. 5 (Supplement).

liberation of their toxins causes a poisoning of the cells immediately around them, and the accumulative action of these toxins, whether locally or at a distance, upon the liver cells, for example, brings about the death of certain cells and replacement by fibrous tissue."

The toxic products of the bacteria are also increased, and, as the normal defences are unable to neutralize them, they pass these defences and are distributed to the tissues, attacking those cells for which they have the requisite chemical affinity. In this manner the organisms or their toxins are absorbed into the blood-stream either directly through the bone, or indirectly via the intestinal canal, and the pernicious influence of oral sepsis thus passes deep into the system and starts other diseases.

Caution is necessary in assuming that oral sepsis is the cause of some other disease with which it is associated until all other possible sources of infection have been eliminated. But even where sepsis in the mouth is not the primary cause, it must not be neglected; otherwise, by lowering resistance, it will assist the pathological process.

It may reasonably be asked why "oral sepsis" does not more often lead to remote conditions. The answer is to be found in the general defences of the body against infection. As long as the reaction of the tissues is able to neutralize the toxic products or destroy the bacteria a normal standard of health may apparently be maintained. But it would appear that the reaction of the tissues to infection cannot be maintained indefinitely and that constant attack weakens the defences until they eventually break down and the tissues become infected. This explanation would fully account for cases in which a septic condition of the mouth has existed for years without giving rise to any remote condition, and has then been followed by a rapid decline in health and the appearance of a definite lesion. The fact that the mouth is immune to disease to an extraordinary degree has already been mentioned in the chapter on saliva, but even here the defences break down under continued strain and serious local pathological conditions arise.

(B) CONDITIONS ATTRIBUTABLE TO SEPTIC PROCESSES IN THE MOUTH

These conditions may be conveniently grouped under the following heads:—

(1) Affections of the mouth and associated parts.

(2) Affections of the respiratory tract.

(3) Affections of the gastro-intestinal tract.

(4) General conditions arising directly or indirectly from bacterial intoxication (toxæmia) or bacterial infection (bacteriæmia).

(1) Affections of the Mouth and Associated Parts

By the spread of infection along the mucous surface, pathological changes in the mucous membrane of the pharynx and larynx may arise, and, by extension down the Eustachian tube, ear trouble may be started.

The crypts of the tonsils are very prone to become infected by sepsis spreading from the teeth. Stewart found that in 231 children with unilateral enlargement of the tonsil, 135 had dental caries and oral sepsis on the side of the enlarged tonsil; 67 had dental caries and oral sepsis on both sides; 16 had no oral sepsis and 15 had dental caries and oral sepsis on the opposite side.

In regard to ulcerative gingivitis (Vincent's angina), the view is held that the tonsillar condition is secondary to the gum condition (see p. 587).

The constant damage to the oral epithelium by sepsis would seem in a few instances to be closely associated with the appearance of epithelioma. In cases of *squamous-celled carcinoma* starting in the buccal surfaces of the cheeks there is invariably a history of long-continued sepsis in connection with the adjacent teeth, and, although many of these patients are syphilitic, the frequent association of oral sepsis with the carcinomatous condition strongly suggests that the two conditions are related.

In the majority of septic processes already described, the damage to the tissue is restricted to the neighbourhood of the teeth, there being sufficient reaction of the tissues to hold the infective process in check. Occasionally this defence breaks down, the infection extends into the deeper parts and a *spreading cellulitis* ensues. In connection with the mandibular teeth, the submaxillary region and deeper tissues of the neck may become involved. The suppuration may spread below the deep cervical fascia and lead to a condition known as "angina Ludovici." In the maxilla the *infection may spread to the orbit* via the maxillary sinus.

The path of transmission is either through the lymphatic system or by the veins. The toxic products in the maxillary sinus create a spreading phlebitis in the plexus of veins situated in the mucous membrane of that cavity. The morbid process enters the orbit either along a direct venous communication through its floor or by means of the facial vein, the facial vein being intimately connected

on the one hand by anastomoses with the veins of the sinus and on the other hand with the orbit, either through the angular vein or by its connection with the pterygoid plexus of veins. The infection may spread by a more superficial route through the periosteum of the maxilla, leaving the maxillary sinus unaffected.[1]

Orbital periostitis and cellulitis are the most common of the troubles which come under this heading. The inflammation may vary greatly in character and intensity, and may be considerably modified by external influences. A diffuse suppurative cellulitis may be set up and involve all the contents of the orbit, threatening the life of the patient by meningitis or septic thrombosis of the cavernous sinus. It is probable that orbital periostitis, either alone or attended by cellulitis, occurs as a complication of dental caries more commonly than is generally supposed. A severe case of suppurative orbital cellulitis of dental origin was recorded by Morton Smale and Juler.[2] The disease may assume a much more insidious form, and may be unattended by proptosis, limited movement, diplopia and the other common manifestations of orbital cellulitis. It may, on the other hand, cause changes in the fundus oculi, viz., papillitis, neuroretinitis, or choroiditis.

Certain cases of *acute retrobulbar optic neuritis* are probably secondary to orbital cellulitis of dental origin. *Ocular muscular paresis*, involving one or more of the extra-ocular muscles, may arise from infection around the teeth and spread to the orbit. Ely reports a case of paresis of the orbicularis palpebrarum in which the paresis disappeared on the evacuation of a dento-alveolar abscess.

Absorption of toxins via the lymphatics may lead to lymphadenitis, either acute or chronic in type.

The glands affected by the teeth and gums are:—

(*a*) *Submaxillary group*, situated in the digastric triangle and running along the margin of the mandible in close relation with the salivary gland. Into this group drain the lower gums, lips, floor of the mouth, sublingual and submaxillary salivary glands, and lymphatics from the tissues around the roots of the teeth. These glands send their lymph partly into the superficial and partly into the deep cervical glands.

(*b*) *Suprahyoid or submental group*, three or four in number and situated between and superficial to the anterior bellies of the

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[1] See case recorded by N. Bishop Harman, *Brit. Med. Journ.*, September 25, 1909, p. 878.

[2] *British Medical Journal*, October 19, 1895.

digastrics. Into these drain the central portions of the lower gums and lips and the tip of the tongue.

(*c*) *Parotid group*, some of which are situated superficially and others more deeply in the parotid gland. Into these may drain the lymphatics from the region of the maxillary molars.

(*d*) *Superficial cervical* along the external jugular vein, receiving lymphatics directly from the gums and indirectly via the submaxillary, but principally from the scalp and skin of the neck.

(*e*) *Deep cervical* over the internal jugular vein. These receive lymph from the gums directly or via the submaxillary glands.

Acute lymphadenitis is met with usually in connection with acute septic conditions of the teeth, but it may be due to the suppuration of a gland which has been chronically inflamed.

Chronic lymphadenitis is more frequently met with, and is important because such glands frequently become the seat of tubercle. One finds a considerable difference of opinion as to the exact relationship of septic teeth to chronic lymphadenitis. It is possible that this difference of opinion is to be attributed to the personal equation, and arises not so much from a difference of the facts as a difference in observation of the facts; thus, a gland which one observer would describe as enlarged would by another be regarded as not abnormal. It is questionable whether a gland should be described as enlarged simply because it is palpable. The most satisfactory test would seem to be to put the skin on the stretch, and if the gland can then be seen, to consider it as enlarged. The test may be carried out as follows: If the glands on the right side are involved, turn and stretch the head towards the left and look at the neck with the light athwart. If the glands cause irregularity of the surface they should be considered as enlarged.

Because septic teeth are associated with chronic lymphadenitis, it does not follow that the glandular enlargement is directly attributable to the teeth; infection from the tonsils, and adenoid tissue around, is probably a much more frequent cause of lymphadenitis than septic teeth.

Where the enlarged glands become the seat of tubercle, the infection probably reaches the glands via the blood-stream and not direct via the lymphatics. There is a growing impression among pathologists that the tubercle bacillus gains an entrance to the body by way of the alimentary canal. The glands damaged by the absorption of toxins are in a state of diminished resistance, and are, therefore, liable to become infected by the tubercle bacilus

contained in the blood-stream;[1] but in whatever way the tuberculous organisms reach the position, the constant association of oral sepsis with tuberculous glands is an indisputable and important fact.

(2) Affections of the Respiratory Tract

The liability of operations on the tongue and jaws to be followed by septic bronchitis or septic pneumonia is no doubt due to the inhalation of moist particles carrying bacteria. Occasionally prolonged etherization is followed by pneumonia and this condition is probably brought about through the ether vapour lowering the vitality of the tissues of the bronchi and finer tubes, and so rendering them more susceptible to infection. The more aseptic the condition of the mouth the less the liability to infection, and it is obvious therefore that the mouth should always be thoroughly disinfected before anæsthetization.

(3) Gastro-intestinal Affections

Gastritis.—There is ample evidence to show that oral sepsis and gastric affections are often closely related. In many instances the gastric condition is the direct result of the constant presence of septic and infective saliva, and cases are constantly occurring in practice in which, with the removal of the oral sepsis, the gastric condition completely clears up. In such cases the chain of events is probably as follows: The food, imperfectly masticated and incorporated with infected saliva, undergoes excessive fermentation, with the result that, sooner or later, a catarrhal inflammation of the gastric mucosa is started. The chronic gastritis is probably of the mucous variety in which the acidity is always slight—a point of considerable importance as far as the inhibition of the microbes is concerned. The catarrhal inflammation is kept alive by the constant presence of the septic matter and may become infective in character.

An examination of the contents of a starved stomach will often show the presence of living micro-organisms. With continued exposure of the gastric mucous surface to infection from the mouth the catarrhal inflammation may lead to glandular atrophy and an increase of the intestinal connective tissue.

In patients with chronic gastric ulcer associated with oral sepsis, there is an increasing belief that there is a causal rela-

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[1] See "The Etiology of Pulmonary Tuberculosis," Sir William Whitla, *Lancet*, July 18, 1908.

tionship between the two conditions. Further, it is held that chronic gastric ulcer predisposes to the development of gastric carcinoma. Steadman examined the dental condition of 21 cases of gastric cancer and found periodontal disease in every one; in 14 cases it was severe, in 5 it was moderate, and in one it was slight. The evidence obtained points strongly to an intimate relationship between oral sepsis and carcinoma of the stomach.

The exact causation of the gastric ulcer frequently seen in young girls is as yet unknown, but there is no reason to believe that it springs from oral sepsis. If, however, oral sepsis is present, healing will be retarded or prevented.

As already explained, the gastric juice under normal conditions inhibits or destroys the majority of organisms entering the stomach, so that the number passing into the duodenum is relatively small. Gastritis interferes with this bactericidal power of the gastric juice, with the result that there is an increase in the number of organisms passing through the pyloric opening and consequently a greater risk of infection in the small intestine.[1]

There is every reason to think that a duodenitis may result from the increased number of organisms passing through the pylorus, and that the infection may spread along the common bile-duct and cystic duct to the gall-bladder. A chronic cystitis is started, a condition which, pathologists maintain, is necessary for the formation of gall-stones. It seems probable that infection may spread along the pancreatic duct and give rise to a pancreatitis, which will cause pressure on the common duct and thus lead to jaundice. This view is supported by the fact that, in many cases of jaundice, Cammidge's pancreatic reaction[2] may be obtained. The passage of the toxic products from the stomach, in addition to starting a duodenitis, may lead to an enteritis and, possibly, colitis. P. Daniel[3] maintains that in cases of oral sepsis the lower part of the ileum is always in an infected state.

With a general gastro-enteritis established, toxic matter will be produced in abundance, which, on being absorbed, will initiate various general lesions. It is proposed to discuss these lesions in the next group. To sum up briefly, it would seem that oral sepsis

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[1] Hankin, as quoted by Adami, found that, in normal health, he could swallow billions of living virulent cholera spirilla without ill-effect. Repeating the experiment when he was suffering from transient gastric catarrh he developed acute diarrhœa with spirilla in the fæces.

[2] In certain pancreatic lesions the kidneys secrete a substance which, in hydrolysis, gives the reaction of a pentose.

[3] *Lancet*, January 15, 1910.

leads to gastritis and that gastritis leads directly or indirectly to a general inflammation of the intestinal canal. It is in the intestine that the toxins are produced in greatest quantity, and it is from this area that they are mainly absorbed.

(4) General Conditions arising from the absorption of abnormal oro-gastro-intestinal Products.

(a) General Debility.—Many patients with marked oral sepsis suffer from a general feeling of ill-health without exhibiting any definite symptoms. There is a lack of energy, a general condition of malnutrition, a sallow, unhealthy appearance, and, invariably, a history of gastro-intestinal disturbance. This condition may be regarded as the result of the continued absorption of small doses of toxins and should be classed as a *chronic toxæmia.* This toxæmia is probably due to (1) absorption of toxic products of organisms; and (2) absorption of toxins produced from abnormal digestive processes. The disappearance of the oral sepsis is followed by a rapid improvement in the gastric condition and the general health; the improvement, be it noted, commencing before the insertion of dentures. In these cases the extraction of the teeth not only eradicates the main source of toxins from the mouth, but also, by removing the cause of the gastro-intestinal condition, stops the formation and absorption of toxins from that area.

The extreme debility seen in children is frequently due to oral sepsis. This subject is discussed in some detail on p. 654.

(b) Chronic Rheumatism.—There is every reason to believe that many of those ill-defined conditions embraced by the terms "chronic rheumatism" and "muscular rheumatism" owe their origin to sepsis, and that the focus of infection is often in the mouth. It is a common experience to find that such conditions clear up with the removal of the oral sepsis. For example, a patient, a woman aged 40, had suffered from tarso-metatarsal rheumatism to such a degree that walking became unbearable; with the removal of a well-marked general suppurative peri-odontitis, the foot condition completely disappeared.

Wynn[1] is of the opinion that these conditions are in no sense related to acute rheumatism but are due to a fibrosis, that is, an inflammation of fibrous tissue of various parts, for example, the sheaths of nerves, the ligaments of joints, the fasciæ of muscles. He considers that the fibrositis is always due to the presence of

[1] "The Relation of Oral Sepsis to General Medicine," *Brit. Dent. Journ.*, August 1, 1912.

toxins. The determining cause is strain from unusual exertion, the constant presence of the toxins acting as a continuing cause.

(c) Anæmia.—In a series of papers communicated during recent years to the various journals, W. Hunter[1] has drawn attention to the association of oral sepsis with severe anæmias.

Chlorosis.—This form of anæmia, so common in young females, has as its chief feature a diminution in the hæmoglobin, the colour index averaging 0·5 and being sometimes reduced to 0·1. There is no evidence to show that chlorosis is caused by oral sepsis, the condition of the mouth in many cases of chlorosis being above suspicion. At times chlorosis and oral sepsis are both present and in such cases a cure of the anæmia is often impossible until the oral sepsis has been removed.

Septic Anæmia.—Under this name Hunter describes a condition in which the "septic factor" is predominant, and owes its origin to sepsis in connection with the oral, gastric and intestinal tract. This anæmia in its severe forms is characterized by (1) "an oligocythæmia comparable to that found in Addison's anæmia, including the existence of poikilocytes, normoblasts and at times megaloblasts"; (2) hæmorrhages; (3) dirty yellow and anæmic complexion; (4) the frequent existence of oral, gastric and intestinal sepsis and symptoms; (5) fever; (6) the severe and often fatal course the disease takes; (7) nervous effects and symptoms in many cases; (8) favourable prognosis, if the cause is removed in time; (9) chronic nephritis; (10) *absence of the hæmolytic and bone-marrow changes found in progressive pernicious anæmia.*" There is reason to believe that this form of anæmia is closely associated with oral sepsis, as a rapid improvement often follows the removal of the sepsis.

Idiopathic or Progressive Pernicious Anæmia.—Hunter regards this type of anæmia as "a specific, hæmolytic, infectious disease, localized to the alimentary tract, with characteristic mode of onset, clinical features and course; hæmolytic and infective lesions."

"Its features include the blood changes above mentioned in connection with 'septic anæmia,' generally more marked and of greater severity than in septic anæmia. They include, however, certain features which mark it off from simple septic anæmia. (1) An intense hæmolysis, accompanied by pigment changes in the

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[1] *Lancet*, January 27, February 3 and 10, 1900. "A Discussion on Pernicious Anæmia and Allied Conditions," *Brit. Med. Journ.*, November 9, 1907, p. 1299. "Oral Sepsis as a cause of Disease in Relation to General Medicine," *Brit. Med. Journ.*, November 19, 1904, p. 1358.

liver, kidney and spleen—these changes being no less characteristically absent in 'septic anæmia,' even the severest forms. (2) A chronic septic infection associated with a specific glossitis and oral, gastric and intestinal sepsis."

In this anæmia Hunter does not consider that septic infection from the mouth or intestinal tract, however severe, can be held to be the direct cause of the disease. In the disease, however, there is often an antecedent history of oral, gastric or intestinal troubles, and he considers that they possibly play an important rôle in the onset of the disease.

(d) Arthritis.—There seems no reason to doubt that the infection in some cases of acute arthritis can be traced to the mouth. An interesting case bearing on this point is recorded by G. Buchanan.[1] A girl, aged 15, developed an acute arthritis of the hip-joint. From a stab incision into the joint a pure growth of *Staphylococcus aureus* was obtained. There was no sore throat or pre-existing disease; the tonsils were slightly enlarged and the teeth were in "a shocking septic condition"; the head was also covered with eczematous eruption due to pediculosis. Buchanan considered that the source of infection was the teeth, especially as there was a slight thickening of the submaxillary glands indicating irritation of some duration.

In a considerable number of cases the mouth condition is a secondary infection. For example, a young man develops an arthritis of the knee from an injury and the condition fails to clear up under the usual treatment. With the removal of the oral sepsis an improvement rapidly follows. In such cases the trauma must be considered as the primary cause and the oral sepsis as a secondary infection. An interesting case showing the relation between the mouth condition and arthritis is recorded by Gordon Watson[2]. The patient was suffering from chronic synovitis of the left knee and he also had periodontal disease. From the synovial fluid a pure culture of *Streptococcus salivarius* was obtained and from cultures taken from the gums and the apex of a root the *S. salivarius* was also cultivated.

Some of the most interesting cases of arthritis are those in which a rheumatic arthritis is complicated by a secondary infection. In these cases the primary attack yields readily to salicylates and, after an interval, a relapse occurs which does not subside

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[1] *Lancet*, April 23, 1910.

[2] *Proc. Roy. Soc. Med.* (Clinical Sect.), vol. iv, p. 141.

under salicylates. For example, a patient with rheumatic fever who has oral sepsis may recover from the rheumatic attack and subsequently suffer from arthritis due to infection from the mouth. Rolleston[1] considers that patients with oral sepsis are specially prone to relapses in rheumatic fever.

Arthritis deformans.—Opinions differ widely as to the proper classification and terminology of the various joint affections grouped under the term "arthritis deformans." Some authors place the various affections in different classes while others regard them as of the same class, differing only in degree and not in kind. The weight of opinion would seem to be in favour of the first view, and it is from that standpoint that we may consider the question in relation to oral sepsis.

Two distinct varieties may be distinguished :—

(1) Chronic infective arthritis—rheumatoid arthritis.

(2) Osteo-arthritis.

Let us briefly consider the morbid anatomy and clinical features of the two varieties.

In *chronic infective arthritis*, according to Llewellyn Jones :—

(1) The morbid process begins in the synovial and periarticular tissues which undergo thickening and proliferation, but the cartilage, at any rate in the earlier stages, remains intact.

(2) The changes that ensue in the cartilaginous and bony structures are secondary and are predominantly atrophic in character.

(3) In some cases proliferative changes take place in the bone and cartilage, but these occasional outgrowths are inconsiderable in size.

(4) In the terminal stages of the disease secondary atrophic changes ensue. Thus the cutaneous and capsular tissues undergo progressive shrinkage, the joint cavity becoming obliterated with fibrous or bony anchylosis. This atrophic process involves also the shafts of the bone, the cortex becoming attenuated and the cancellous tissues replaced by scanty thin trabeculæ.

Horder[2] considers that the infective element is usually a type of streptococcus, not *S. pyogenes* but *S. salivarius* or *S. fæcalis*—i.e., streptococci of relatively low virulence, not tending to suppuration and traceable, as the names are intended to suggest, to the mouth or intestine. Reliable observations have also established the presence of gonococcus, pneumococcus and *B. coli.*

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[1] *Brit. Med. Journ.*, October 15, 1910.

[2] "Vaccine-Therapy in Rheumatoid Arthritis." *Lancet*, April 20, 1912, p. 1053.

Clinically, the condition is frequently associated with and subsequent to affections of avowedly infective or toxic character. The disease is a progressive polyarthritis and runs an acute or chronic course with remissions and exacerbations. It is usually met with in patients under 40 years of age and is more common in women than in men, but it is seen about equally in boys and girls. The disease usually begins at the small joints; it has a tendency to symmetrical distribution. The more exposed joints become the seat of smooth, spindle-shaped swellings; eventually the enlarged joints undergo contraction or shrinkage, the skin, bone and cartilage participating in the atrophic change. Constitutional symptoms, such as rise of temperature, quickened pulse, &c., may be present.

In *osteo-arthritis* the disease starts in the cartilages; these become thinned, and where pressure is greatest the cartilages become worn away, the denuded ends of the bone becoming sclerosed and their surfaces eburnated. In the peripheral portion of the cartilage not subjected to pressure, proliferation takes place and osteophytic outgrowths are developed. The changes taking place in the synovial membrane are secondary in character. Clinically, the disease is not intimately connected with infective conditions. There is frequently a clear history of trauma. The big joints are generally affected and usually only one. The disease attacks both sexes equally; belongs to the middle and later periods of life and is usually associated with arteriosclerosis and senility.

There is an abundance of clinical evidence to show that the focus of infection in chronic infective arthritis is frequently traceable to the mouth. It is indeed remarkable how many of these patients improve with the removal of the mouth sepsis. But although an active source of sepsis is invariably present in the mouths of these patients, the possibility of other foci of infection must not be overlooked, for example, the vagina, the intestinal canal, the urinary system, bronchiectasis, &c.

With regard to osteo-arthritis, clinical evidence does not suggest that oral sepsis can be regarded as the factor in producing this condition. Cases of osteo-arthritis are often associated with periodontal disease and the treatment of the mouth condition is followed by an improvement in the general health, and in that way the general condition is naturally benefited. P. Daniel[1] considers that gastro-intestinal sepsis is an important factor in the causation of osteo-arthritis and that the gastro-intestinal condition is always initiated by oral sepsis.

[1] "Arthritis: a Study of the Inflammatory Diseases of Joints," p. 136.

The following cases are quoted to show the relation of oral sepsis to arthritis deformans:—

A married woman, aged 30, was seen in February, 1911, suffering from an arthritis involving several of the large joints. The remaining teeth $\frac{3\,2\,1\,|\,1\,2\,3}{4\,3\,2\,1\,|\,1\,2\,3\,4}$ were loose. Skiagrams of the alveolar process showed rarefying osteitis and marked absorption of the roots of the teeth. The remaining teeth were extracted. From the apex of one of the teeth an almost pure culture of *Staphylococcus pyogenes albus* was obtained. When seen in June the patient stated that she felt much better and was able to walk fairly well. In July, 1918, she reported that there had been no return whatever of her arthritis.

A man, aged about 50, was suffering from sciatica. There was osteo-arthritis of the hip joint. The mouth was septic owing to periodontal disease. The following teeth were present:—

$$\begin{array}{cccccccc|cccccccc} & 7 & 6 & 5 & 4 & 3 & 2 & 1 & 1 & 2 & 3 & & & & 7 & 8 \\ \hline 8 & & & & 4 & 3 & 2 & 1 & 1 & 2 & 3 & 4 & 5 & & & 8 \end{array}$$

The premolars and molars were removed. The teeth were firm and extractions were difficult. The skiagrams of the case suggested that there was considerable sclerosis of the bone, more especially in the mandibular incisor region. A culture taken from the apex of one tooth showed *S. pyogenes aureus* in abundance with a few streptococci and *S. epidermidis albus*. Six weeks after removal of the teeth the patient stated that the sciatica was much better and that his general health had improved.

(e) Diseases of the Heart.—Cardiac Irregularity.—Cases of this character are by no means uncommon, the relief to the heart symptoms almost immediately following the removal of the septic foci in the mouth. The irregularity of the heart may be explained on the assumption of a toxin from the mouth or gastro-intestinal tract having a specific affinity for certain of the cardiac nerves.

(f) Infective Endocarditis.—The organisms identified with these conditions are various and indicate that the disease is not due to any one special organism, but solely to pyogenic infection. There is evidence that the teeth may be the primary source of infection. A most instructive case was reported by H. Hemsted.[1] A young female with congenital malformation of the right ventricle developed a dento-alveolar abscess in connection with the left mandibular first molar. Novocain was used by the infiltration method and the tooth removed. The next day feverish symptoms

[1] "A recovery from Infective Endocarditis (Streptococcal)." *Lancet*, January 4, 1913, p. 10.

appeared and persisted for three or four days and then subsided, the patient resuming her normal life. The patient subsequently developed an infective endocarditis, the streptococcus obtained from the blood having the same characteristics as the *Streptococcus salivarius*.

In another case recorded by H. P. Pickerill[1] a staphylococcus, *Streptococcus salivarius* and a short bacillus (possibly the *Bacillus necrodentalis* of Goadby) were present *post mortem* in the mouth, the bronchi, the alveoli of the lungs, and on the valves of the heart.

(g) General Infection.—That general infection may result from lesions associated with the teeth is shown by cases which have been reported from time to time. The majority of these cases have been in connection with acute dento-alveolar suppuration.

The suppuration of a chronic character such as is seen in general periodontal disease (pyorrhœa alveolaris) must, however, also be regarded as a potential cause of general infection. A case of this type is recorded by G. Bellei,[2] and is instructive, as it demonstrates the sequence of events: (*a*) Suppurative periodontitis; (*b*) septic tonsillitis; (*c*) general infection.

The patient was a man, aged 48, who had been in good health until the age of 40 years, when he began to suffer from chronic inflammation of the gums and the maxillary alveoli, accompanied by the formation of pus. At the age of 45 years his right testicle was removed because it was found to be affected by tuberculosis. He made a good recovery after the operation, and, apart from his dental trouble, his health was satisfactory. One day he was attacked with a severe sore throat, which he did not treat in any way, but went to his business as usual. In the evening he had a violent fit of shivering followed by high temperature, and it was obvious that the sore throat and pyrexia were caused by a phlegmon of the pharynx. In the course of the next few days an abscess formed in the right tonsil. This abscess was opened four days after the beginning of the inflammation of the pharynx; a moderate quantity of pus escaped which, on cultivation, showed the presence of a very small streptococcus and of a saccharomyces. After the operation the patient felt very much better, the pain in his throat subsided, so that he became able to swallow, and his temperature, which had hitherto been about 100° F., fell to 98°. But about 7 a.m. next day he was suddenly seized with a shivering fit, followed by a rise of temperature to 104°. The suspicion of a general infection produced by one of the micro-organisms that had been found in the pus of the abscess was suspected, and with a view of confirming the diagnosis some blood was taken from a vein of his left arm. As it seemed probable that the infection was due to the streptococcus, the use of Marmorek's serum was begun in order not to lose time. In the first twenty-four hours 50 c.c. were injected, but the patient's condition grew worse, and his temperature remained permanently high, being always about 104°. The use of

[1] *Brit. Med. Journ.*, February 13, 1909, p. 394.

[2] *Lancet*, March 22, 1902.

Marmorek's serum was continued during the next two days, but in spite of it the patient died from failure of the heart, unaccompanied by any localized lesion.

The micro-organism isolated from the blood was a streptococcus, which had the same microscopical character as that found in the abscess.

(h) Intermittent Fever.—There is a class of disease characterized by an irregular temperature of long duration to which no definite cause can be assigned. This condition may be regarded as a subacute septicæmia, and there is evidence that in some instances the teeth are the focus of infection as shown by the following case:[1] A male, aged 30, was admitted to hospital on July 11 with headache, pain in the back and slight cough. The temperature was 102·2° F.; th pulse-rate 98, and the respiration 24. There was no history of tropical disease. There was marked oral sepsis. Leucocytosis, 19,200. The case was regarded as one of light apical pneumonia. During the following two weeks the condition was as follows: "Intermittent fever had been present; the temperature had been at its highest (102-103·5° F.) almost every day at 6 p.m., and the pulse-rate had risen synchronously. The leucocyte count had varied between 20,000 and 24,800, the differential count always showing an increase of polymorphonuclear cells. The blood had been examined twice for organisms and on several occasions for the malaria parasite, always with negative results. Large doses of quinine had been given without any relief to the symptoms. The urine had been twice examined and was sterile. Slight general bronchitis had been present; repeated examinations of the sputum for the tubercle bacillus had been made with negative result.

During the first half of August the patient improved as regarded his temperature, but from the 14th onwards intermittent fever recurred, with increased pulse frequency and leucocytosis. He lost ground rapidly and on August 25 his weight was only 9 st. 12 lb., having fallen from 10 st. on August 4. Since his condition pointed beyond any doubt to some form of persistent sepsis, and since the most exhaustive examinations had failed to elicit the slightest clue to any other source, it seemed reasonable to incriminate the septic teeth. The patient, who had refused early in his illness to undergo dental treatment or to believe that his teeth, which "had never ached in his life," could be the cause of his trouble, now yielded more easily to fresh pressure, and on August 30 five carious roots were removed. On this day his temperature was 103° F., pulse-rate 116, and weight 9 st. 10¾ lb. On September 3 three teeth were

[1] Recorded by A. Abrahams, *Lancet*.

extracted. The temperature remained intermittently raised as before until the 10th, and not a little doubt was cast upon the advantage of his dental experience. But on that day the temperature fell to 97° F., and for the rest of his stay in hospital (until October 2) it never rose above 98° F., the pulse-rate varying from 44 to 92. On September 20 the last seven offenders were extracted.

More striking than the cessation of fever was the general improvement. As stated above, the weight on August 30 was 9 st. 10¾ lb. On September 16 it was 10 st. 4 lb.; on the 23rd, 10 st. 8¾ lb.; and on the 30th, 11 st. The patient, despite obvious masticatory difficulty, "could not get enough to eat."

A final point of interest was the leucocyte count. On August 22 it was 19,000; polymorphonuclears, 81·8 per cent. On September 10, 28,200; polymorphonuclears, 79 per cent. On the 16th, 19,200; polymorphonuclears, 71 per cent. (Temperature on this day 97·4° F., pulse-rate 64.) On the 21st, 27,200; polymorphonuclears, 75·1 per cent. (Temperature on this day 97·8° F., pulse-rate 60.) On the 28th, 11,800; polymorphonuclears, 66 per cent. On October 2, 9,000. In other words, the polymorphonuclear leucocytosis persisted with gradual subsidence during the completely apyrexial period of his recovery.

An equally instructive case is recorded by C. W. Smith and H. E. Barnes in the *British Medical Journal*, September 18, 1909, p. 740.

(i) Diseases of the Eye.—Oral sepsis as a source of disease in the eye has been definitely established. Out of 215 cases of inflammation of the eye, which W. Lang[1] attributed to sepsis, 129 were eventually traced to periodontitis. He found also that the more vascular parts, the iris, the ciliary body, the choroid, were affected seven times more frequently than the less vascular sclerotic, retina, and optic nerve, and only in one instance was the cornea primarily attacked. It is probable, therefore, that the poison is carried in the blood-stream.

I am indebted to Mr. Lang for the following account of the relations of dental sepsis to eye lesions:—

As the pathology of these eye affections is still obscure it is only possible to prove that these diseases of the teeth and of the eye bear the relationship of cause and effect by selecting cases where only one source of sepsis appears to be present, removing it and watching the result. In this way and without any other treatment recently lost sight has been rapidly regained, and acute attacks

[1] Supplement to *Proc. Roy. Soc. Med.*, May, 1913.

of inflammation have been cut short and have not recurred, whereas in former times, when the source of sepsis was not removed, the sight in similar cases was not restored in spite of every known treatment and the attacks of inflammation recurred until the eye was lost.

The following is a list of affections which periodontitis may cause:—

Interstitial keratitis.

Scleratitis and episcleritis.

Iritis and iridocyclitis with exudation into the vitreus followed by secondary cataract and secondary glaucoma.

Central choroiditis, which was formerly described as senile central choroiditis, and was attributed to senility when the patient was elderly, though similar disease occurs in young people, but not so frequently.

Disseminated choroiditis, confluent and discrete, which may be followed by detachment of the retina.

Choroidoretinitis.

Optic neuritis. Progressive myopia and asthenopia.

Until quite recently these diseases were attributed either to gout or to rheumatism, whenever tubercle, syphilis, gonorrhœa, diabetes, albuminuria and fevers could be excluded. It is now known that they are more frequently due to some septic infection in the proportion of thirteen of septic to ten of all other kinds. The following instances illustrate this view:—

Episcleritis.—A female patient with this condition, which had been present for five months, recovered after treatment of the periodontitis. The condition recurred and, after lasting a year, all the teeth were removed. The next day the eye was whiter. The general health improved and she said "life was worth living," and the eye recovered rapidly. Two years later she had appendicitis and the episcleritis returned; both diseases quieted down together and six years later neither had recurred.

Kerato-iritis with Vitreous Opacities and Secondary Glaucoma.—A man, aged 37, with normal vision $\frac{5}{5}$ in each eye, had mutton-fat keratitis punctata and periodontitis, for which he was treated. A year later, when he was seen, he could only count fingers at 2 ft. with the right and at 1 ft. with the left eye. The vitreous was too hazy for the fundus to be seen, the tension was raised and the field of vision contracted in the right eye. All the teeth were condemned, and when they had been removed the vision began to improve. Three years later the vision in each eye was $\frac{5}{5}$ and SN 0·25′.

Central Choroiditis.—An officer of the Yeomanry who thought himself to be in good health, noticed two days before coming under observation a brown stain on the newspaper. On covering one eye he observed a blur which involved the fixation point; this was found to be due to a small patch of central choroiditis which had reduced the vision to $\frac{5}{6}$ slowly. Five days later the brown mist had gone and the vision was $\frac{5}{5}$. In the interval three septic roots had been removed and his periodontitis treated.

Kerato-iritis with Vitreous Opacities and Secondary Glaucoma.—A lady, who had suffered from recurring attacks of inflammation in both eyes for fifteen years, during which one eye had been excised and a secondary cataract removed from the other, came under observation for attacks of glaucoma which obscured the sight every morning, but cleared again at night when she saw very well. In this state of obscuration which reduced the sight to the counting of fingers at a distance of 3 ft., all her septic teeth were removed under a general anæsthetic. On regaining consciousness the vision was clear. A year later it was reported to be normal and never to have been again obscured.

Disseminated Choroiditis.—In this patient disseminated choroiditis in one eye had reduced the vision in six months to $\frac{6}{60}$. She had all her teeth removed for periodontitis. In two days the vision was $\frac{6}{9}$; three weeks later it had gone back to $\frac{6}{24}$; a root which had been overlooked was removed the same day and within a few days the vision returned to $\frac{6}{9}$.

Operation for Senile Cataract.—A lady with a septic mouth which she refused to have treated before an operation for senile cataract, submitted to the removal of all her teeth when an iritis began to cause pain four days after the cataract had been extracted. The same day the pain in the head and eyes was less, and the inflammation ceased to increase; two days later the gums, which could not be cleaned up before the teeth were removed, were foul, and the eye was worse. In a few days the gums were clean and at the same time the eye improved and recovered very quickly and was well within three weeks. In similar cases where the source of sepsis is not removed, the eye remains inflamed for many weeks.

(j) Deficient Lactation.—There is evidence that dental sepsis is sometimes responsible for deficient lactation. H. Waller[1] has drawn attention to this condition and has found that the removal of the sepsis is often followed by a rapid improvement in the condition of the child. By way of illustration two cases may be quoted.

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[1] "Dental Disease in Nursing Women." *Lancet*, November 4, 1916.

(1) A child was born above the average weight and was healthy in appearance. The mother had nursed one child with success, but this one cried unduly and vomited the milk from time to time. The child's gain in weight became unsatisfactory. Reference to the chart, fig. 794, shows that at the end of the twelfth week the child had lost the initial advantage which he had over the average child at birth. The sepsis in the mouth was treated by the removal of

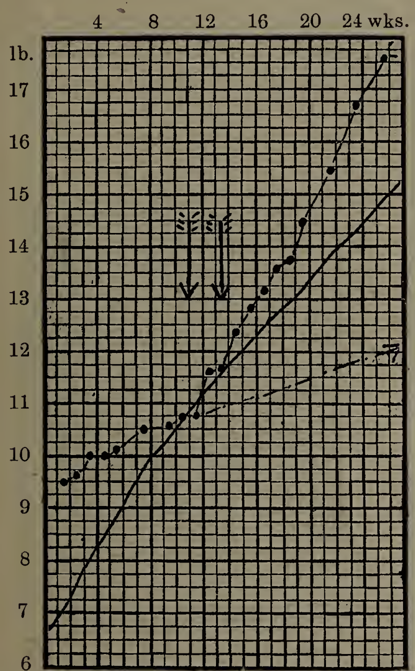

Fig. 794.—*Lancet*, p. 786, November 4, 1916.

Case 1.—Weight curve of child. The continuous line is Budin's curve. The interrupted line gives the record of the child's weight. The arrows denote the extraction of maternal teeth ; three in the first case, two in the second. The direction of the interrupted line before the extraction would lead to a weight of 14lb. at one year, after the extraction to one of 22lb.

three suppurating teeth when the child was eleven weeks of age and two a fortnight later. The rapid improvement of the infant following the removal of the sepsis is shown in the chart.

(2) A child was born below the normal weight and when seen at three and a half weeks of age was undersized and appeared to be wasting. The mother had a copious supply of milk. The vomiting of the child after the feeds was not due to excessive feeding as a similar condition followed feeds of a few minutes. A rapid

improvement in the infant's condition followed the removal of the dental sepsis, as shown in the chart, fig. 795.

(k) General Conclusion.—Speaking generally, it may be said that the course of all diseases may be influenced by oral conditions. Recovery depends upon the reactive qualities of the tissue, and it is logical to suppose that such reactive qualities must depend very largely upon the quality of the substances absorbed from the whole intestinal tract. In acute illnesses, such as the exanthematous fevers, and conditions such as septicæmia and pneumonia, the prognosis must necessarily be greatly influenced by the presence or absence of oral sepsis. Thus, it has been shown by W. Hunter that in scarlet fever the severity of the mouth lesion and the

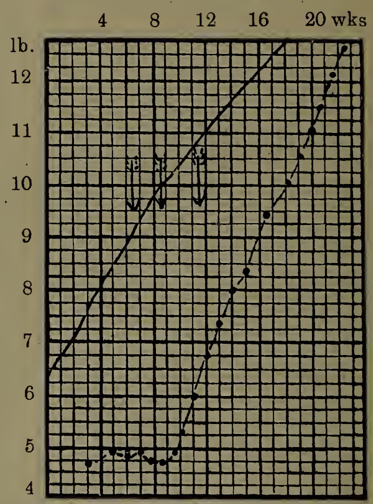

Fig. 795.—*Lancet*, p. 787, November 4, 1916.

Case 2.—Weight curve of child. Lines as before. The arrows indicate the extraction of eight teeth, twelve teeth and four roots, and eight teeth respectively.

duration of the disease are markedly influenced by oral sepsis. Again, in diphtheria, the symptoms vary in intensity. The intensity may depend upon the relation of the individual resistance and the toxicity of the organisms or it may depend upon a secondary or superadded infection. It is clear, therefore, that with a septic mouth severe forms of this disease are more likely to occur. Further, it is probable that oral sepsis, by chronically damaging the mucous membrane of the fauces, produces a favourable medium for the growth of the diphtheria organism.

The importance of oral sepsis in connection with acute pneumonia cannot be doubted. The fevered mucous membranes, the rapid

breathing, the open mouth, the frequent expectoration, are in themselves sufficient to lead to unhealthy oral conditions; but add a pre-existing oral sepsis and the condition of the patient becomes deplorable, and the prognosis infinitely less hopeful. In typhoid fever also the added sepsis must be of serious moment, and is possibly responsible for the recurring rises of temperature at times seen at the commencement of convalescence.

In common anæmias and many cases of mal-nutrition little or no improvement follows treatment by drugs should oral sepsis be in existence; indeed, the removal of the oral trouble in itself is often sufficient treatment.

It must not be forgotten that certain forms of chronic constipation are dependent upon a chronic colitis leading to excessive formation of mucus. The chronic colitis may in itself be secondary to oral sepsis and be permanently incurable without removal of the oral trouble.

In conclusion, to quote the words of my brother, S. Colyer,[1] "The somewhat bizarre nature of the effects that have been attributed to oral sepsis may at first sight make the relationship appear improbable, overstated and even ridiculous; but when once the principles that underlie the subject have been grasped, it will be realized that the conclusions are a necessary outcome. In all diseases there are always two factors at least, the seed and the soil, without which disease cannot exist. The seed varies, the soil varies; never are the two the same; never is the relation repeated. This is why variation in disease occurs, and in no two persons does it run a precisely similar course. Oral sepsis, let it be repeated, is but a comprehensive term to include various forms of septic conditions in the mouth; it is not a disease. The germs causing the sepsis vary, and so the germs passing into the body, and the toxin absorbed, produce different results in different people. It cannot be said precisely why germs of a particular kind entering one body produce a septicæmia, and in another an infective endocarditis; or why a toxin in one will produce anæmia and in another a neuritis; but that such is the case seems almost certain, and one must rest content for the moment with the fact, and believe that the future will unfold more of the reason why."

With a view of relieving the text, detailed accounts of cases supporting the statements contained in this chapter have been omitted. *The following articles are given for reference:—*

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CHAPTER XXVI

Diseases arising from Reflex Irritation from the Teeth

Affections of the Nervous System—Affections of the Ear—Affections of the Eye

In past years various lesions of the eye, ear and other organs were attributed to reflex irritation from the teeth. In reading the accounts of many of these cases, one is driven to the conclusion that the diagnoses were often incorrect, and that diseases which were merely coincident were frequently wrongly associated in a causal relationship. The histories of the cases, when read by the light of modern pathology, would suggest that, in the majority of the cases, the lesions attributed to the teeth were the result of septic absorption rather than reflex irritation.

(A) AFFECTIONS OF THE NERVOUS SYSTEM

Epileptic and Convulsive Seizures.[1]—It is possible that epilepsy may be induced by dental irritation. Brown Sequard found that, after section of one of the lateral columns of the cord anywhere between the medulla and the tenth dorsal vertebra, epilepsy could be induced by very slight irritation of the fifth nerve. The following case is recorded by Bakewski[2]:—

"A young female had suffered from epileptic seizures for nine months, the fits having increased in frequency, there being several every day. The usual drugs were tried without effect. Finally, the teeth were examined and the maxillary right first molar and the mandibular left first molar were found to be carious. These were removed and the fits ceased entirely and did not return, the patient being kept under observation for six months subsequently. Upon being closely questioned, the girl remembered that before the fits commenced she had had some unpleasant sensations in the affected teeth, but nothing that could be described as pains."

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[1] The cases recorded under this and subsequent sub-headings have been introduced in order that the student may gain some idea of the evidence on which the relationship between reflex dental irritation and other diseases is based.

[2] *Journ. Brit. Dent. Assoc.*, vol. xii, p. 280.

The following case is related by Rams Hill[1]:—

"A boy, aged 13, has had frequent attacks of epilepsy for the last eighteen months. Latterly, his mother has noticed that some days he rubs his left cheek, complaining of faceache, after which the fit follows. On examining the mouth there is to be seen a molar tooth considerably decayed, with a swollen gum around it and partly growing into the cavity; it is not very tender to the touch and the examination does not give rise to toothache. On questioning, I find the sensation which the boy experiences before a fit does not seem to be one of pain, but rather of an indefinite uneasiness. He always has a fit the night this comes on. Has never felt it during the day; it is always about seven or eight o'clock. I desired the mother to have the tooth extracted and ordered a simple saline with a quarter of a grain of belladonna to be taken twice daily. This was in June. The tooth was extracted next day. I saw this boy once a fortnight from that time for four months, but he has had no recurrence of the fit. In this case I believe an unfelt aura commenced about the gum surrounding the tooth and was not recognized till some degree of inflammation arose, thus a modification of pain became associated with the aura and directed attention to it."

The precise pathological condition of the teeth in these two cases is not stated, and it seems highly probable that in both of them a septic periodontitis was present. If that were the case they could hardly be regarded as examples of epilepsy caused by reflex irritation, but should rather be classed as cases due to septic absorption. That sepsis may influence the course of epilepsy is well demonstrated by a case which came under my notice. A man had been the subject of epilepsy for fifteen years, and had had as many as three fits in a day. There was extreme dental sepsis and this was treated and removed. At the end of a year he reported that he had slight fits occasionally in his sleep, which were noticed by his wife, but that there was often an interval of three weeks without any attacks.

A case of some interest also came under the observation of Morton Smale:—

"A patient, aged 22, a male, always showed distinct signs of *petit mal* during the operation of filling, the symptoms being always more marked if an exposed nerve were touched. This patient, to the best of his recollection, had never suffered at any time with epilepsy, nor had he had fits of any other character."

With persons subject to epilepsy it is not uncommon for a fit to be induced by the irritation attending dental operations.

Chorea.—Some medical writers are of opinion that chorea may in some instances be connected with dental irritation. Chorea is a functional condition and it is possible that the dental lesion may

[1] *Medical Times and Gazette*, 1862, vol. ii, p. 216.

induce chorea, either directly by reflex irritation or indirectly by lowering the vitality. The following case, quoted in the "American System of Dentistry," would seem to indicate that the dental trouble was intimately connected with the choreic condition. The case is related by C. N. Pierce[1]:—

"A boy, aged 9, had always been in good health until two years ago, when he was attacked with choreic movements chiefly in the muscles of the face, though present also in the muscles of the neck and shoulders. Owing to their local character, and the absence of the causes usually assigned for the appearance of chorea, it was thought possible that the condition of the teeth might offer some explanation of the trouble. Careful examination of the mouth revealed, in addition to considerable overcrowding of the teeth, persistence of the deciduous incisors. Upon their removal the choreic movements at once subsided. After an interval of a year there was a return of the symptoms. Examination of the teeth again showed a persistence of the deciduous molars delaying the eruption of the premolars. Removal of the offending teeth was followed by complete recovery."

Spasmodic Closure of the Jaws.—The following case was reported by Ewart[2]:—

"The patient, a man, aged 47, moderately addicted to alcohol, was suffering from an extensive chronic ulcer of the right leg. His illness began with a 'severe cold' three weeks before his admission into St. George's Hospital on September 20, 1899. The trismus set in quite suddenly during the night a week later, when he awoke in a fit of suffocation due to the closure of his lips unsupported by teeth. The same nocturnal attacks continued to occur in the hospital for five weeks. The rigidity of the jaws, of the floor of the mouth, of the platysma of the neck, and of the abdominal muscles was intensified by excitement, but there was neither opisthotonos nor any spasm of the limbs. Speech, respiration and alimentation were much impeded, leading to loss of flesh and weakness. There was a tender and slightly swollen spot on the gum, and the case was diagnosed from the first as one of reflex spasm due to periosteal irritation and tenderness at the left posterior extremity of the upper jaw, and local treatment was recommended. This was finally resorted to, after various remedies had proved ineffectual, at the end of October, and the symptoms rapidly disappeared after the tender gum had been freely incised."

This case was probably purely reflex, the absolutely edentulous and healthy condition of the gums excluding the theory that septic infection from the mouth was the cause of the spasmodic closure of the jaws.

Many cases of so-called trismus arising from the teeth are not due to spasm of the masseter muscles as is usually supposed. The closure of the jaw in most of the cases arises from infiltration of

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[1] Vol. iii, p. 598.

[2] *Brit Journ. Dent. Sci.*, January 11, 1900.

the muscles and adjacent tissues, the interference with the movement of the jaw being due partly to mechanical impediment from the inflammatory products and partly to involuntary closing of the jaw.

Paralysis of the Arm.—In the chapter on odontalgia reference was made to the occurrence of pain in the arm, which was traceable to the teeth. It is interesting to note that cases of supposed paralysis of the arm have been recorded as due to dental lesions. Salter[1] records the following:—

"Miss B., aged 24, consulted me on October 15, 1864, respecting the left lower wisdom tooth, and the symptoms to which it had apparently given rise. The tooth had pierced the gum, but it was low down and placed horizontally, the crown pressing forwards against the second molar. The tooth was carious. From the first attempt at the eruption of this tooth there had been much pain of the ordinary kind about the angle of the jaw; latterly it had been intense, and for a fortnight there had been paralysis of the left arm; the patient complained of total inability to use the arm, to raise it or grasp with the hand; she could not employ the limb in dressing herself, and could not hold her fork at dinner. There was also a continuous pain of the whole arm resembling rheumatism. The tooth was extracted, but with extreme difficulty. As soon as the patient recovered from the pain of the operation she declared that the arm symptoms had vanished completely."

J. H. Mummery records[2] that whenever he suffered from much pain in a left lower molar he could raise his arm only with great difficulty and experienced a sense of weight and fatigue in the arm almost amounting to pain.

In Salter's case, as in many similar records, no electrical examination of the muscles could be recorded. Before arriving at a diagnosis of paralysis it is always advisable to exclude hysteria, and to satisfy oneself that the case is not one in which the part is involuntarily kept inactive in order to avoid pain.

Spasm of the Sternomastoid (Wry-neck).—A case of spasm of the sternomastoid has been recorded by Hancock.[3] The patient, a woman, had suffered considerable pain in the left shoulder, apparently owing to the presence of a carious tooth on the left side of the mandible. The head was drawn down nearly to the left shoulder. On removal of the tooth the condition disappeared. In this case, as in others recorded, there was probably no true spasm of the sternomastoid, the head being placed involuntarily in the bent position as a result of the pain.

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[1] "Dental Surgery and Pathology," p. 264.
[2] *Brit. Med. Journ.*, September 9, 1905.
[3] *Lancet*, 1859, p. 80.

Tonic Spasm of the Upper Extremities.—In the following case the spasm of the muscles would seem to have been related to pulp irritation:—

"A robust, strong man of 29, who was not in the least nervous, suffered from toothache, caused by an exposed pulp in the upper left third molar. During repeated attempts at luxation of the tooth, which was fixed very firmly, the forceps slid off and struck directly into the pulp. There was at once a tonic cramp of the flexor muscles of all fingers on both hands. Especially the left hand was closed so tightly that the patient could not open it, whilst he had some difficulty in opening the right. The flexibility of the arms was also affected. The patient, describing his condition, said he felt as though a very strong electric current passed through his head and arms, or as if the latter had pins and needles in them; a painful condition which caused the patient, usually showing great powers of endurance, to groan pitifully. Concentrated carbolic acid was applied to the pulp, whereupon the cramp gradually ceased. On the tooth being extracted the patient became normal, and could follow his business undisturbed all day long."[1]

(B) AFFECTIONS OF THE EAR

Affections of the ear due to reflex irritation from the teeth are uncommon, and in many cases formerly attributed to reflex irritation from the teeth it is probable that a septic periodontitis was present, and it would seem more reasonable to regard the septic absorption from the teeth as a continuing cause that is aggravating a condition started by other causes.

Otalgia.—Otalgia is frequently traceable to teeth. Politzer states[2] that carious teeth are the most frequent causes of otalgia in children. Otalgia unaccompanied by any inflammatory or other abnormal phenomenon in the ear itself which would account for the trouble, is invariably connected with the teeth, and in such cases the teeth should always be examined. Even when the ear symptoms appear to be sufficient to account for the otalgia the possibility that the condition of the teeth may aggravate the pain should not be overlooked.

Deafness without definite lesions in the ear is at times apparently traceable to reflex trouble from an unerupted third molar. In a case under my care a patient developed what she termed a "worry" in the ear, which interfered with hearing. The ear was free from organic disease, and the only possible cause in the mouth was an unerupted misplaced third molar. With the eruption and removal of this tooth the symptoms passed away. J. Howard

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[1] This case was recorded by G. Randorf in *Items of Interest*.

[2] Edition, 1909, p. 686. Translated by Messrs. Baillie and Heller.

Mummery[1] records a case of considerable deafness on the left side, which had existed for months in association with the delayed eruption of the maxillary third molar. The hearing was much relieved immediately after the extraction of the tooth and was fully restored the same day.

(C) AFFECTIONS OF THE EYE

Lachrymation.—Apart from an emotional flow of tears from the distressing pain of odontalgia, the eyes will occasionally become suffused with tears through sudden pain caused by biting on a sensitive tooth. This is similar to the reflex overflow of tears produced by pungent vapours, e.g., strong ammonia.

Spasm of the Orbicularis palpebrarum: Blepharospasm.—Excessive blinking is a mild variety of chronic spasms of the orbicular muscle of the eyelids. Knies has seen a case of this kind disappear immediately after the removal of a painful tooth.

Blepharospasm is occasionally traceable to reflex dental irritation, and in such instances can be cured by attention to the teeth. Blepharospasm may, however, occur in elderly people with edentulous jaws. In these cases it is supposed that the osseous sclerosis present causes the spasms reflexly by the imprisonment of filaments of the dental nerve. Such cases are difficult, in fact almost impossible, to cure. The spasm involves, in addition to the orbicularis palpebrarum, many of the other muscles supplied by the facial nerve. It varies from a slight twitching of the orbicular muscle to a violent spasmodic contortion of the whole side of the face. It is usually asymmetrical, and is mostly seen in elderly females. It has no association with *tic convulsif.*

Spasmodic contraction of the internal rectus muscle is manifested by an internal or convergent strabismus. A squint not infrequently develops during the period of the eruption of the deciduous molars, and many mothers assert that the squint is due to the dental irritation. This is true only so far as the disturbance created by the eruption of the teeth acts as the determining cause of the strabismus. The fundamental cause, hypermetropia, being present, any condition which impairs the health of the child and interferes with the disestablishment of convergence (a dissociation which must inevitably take place to avoid a squint) must lead to convergent strabismus. Convulsions, measles, whooping-cough, adenoids, &c., are all in turn credited as the cause, and early dentition is perhaps as common a determining cause as any.

[1] *Brit. Med. Journ.*, September 9, 1905, p. 553.

Spasm of Accommodation.—Spasmodic contraction of the ciliary muscle, similar to spasm of the internal rectus, seems occasionally to have a reflex dental origin. Attention to the teeth will sometimes cause a chronic ciliary spasm to relax, and thus cure a troublesome case of apparent myopia.

Paresis of the Levator Palpebræ Superioris.—Hancock[1] and Nicol[2] have each recorded a case of ptosis which disappeared after the treatment of carious teeth. In all probability the ptosis in these cases was purely functional.

Paralytic Strabismus.—It is impossible for a paralytic squint to be produced reflexly from any source of irritation, though some observers think that they have seen a paralysis of an ocular muscle produced by dental irritation. Such cases are probably due to direct continuity of disease (see p. 673).

Muscular Insufficiency with diplopia has been attributed to painful carious teeth.

Paresis of Accommodation.—Accommodative failure, attended by asthenopia, is recognized by many surgeons to be due to diseases of the teeth. Schmidt[3] found it present seventy-two times in ninety-two cases of dental caries. It probably results, as Knies[4] suggests, from the lack of vigorous innervation on account of the distressing pain. On the other hand, Priestley Smith found unimpaired accommodation in fifteen out of sixteen cases of odontalgia.

Amaurosis and Amblyopia.—Amaurosis, or complete functional loss of sight, and amblyopia or impaired visual acuity, are two functional conditions which have repeatedly been attributed to reflex dental irritation. There are many such cases on record. In some of them there was probably an acute retrobulbar optic neuritis, the result of inflammation by continuity (see p. 674). In others the elements of hysteria were probably very predominant. Galezowski records a case in which a lady suffered from impaired vision after a tooth had been stopped; her vision improved on the removal of the filling and relapsed again when the tooth was refilled. The removal of the tooth wrought a permanent cure.

The following case of amaurosis consecutive to the extraction of a tooth is recorded by Santamaria (*La Stomatologia*, Milan, July, 1906).

The patient was a soldier who, prior to enlisting, had followed the occupation of portrait painter. Six months after his arrival at the Florence

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[1] *Lancet*, 1859, p. 80.

[2] *Trans. Odonto. Soc.*, November, 1895.

[3] *Arch. f. Ophthal.*, xiv, p. 107.

[4] "Relation of Diseases of the Eye to General Diseases," p. 267.

barracks he suffered from a violent attack of pulpitis in the upper right first molar, which tooth, being badly decayed, was extracted at once. A few hours after the extraction the patient again suffered from a neuralgic attack, the pain radiating from the right cheek to the eye of the same side, and from a rapid and progressive diminution in the visual power of the right eye, which very soon became amaurotic. This condition lasted five days, and, ceasing abruptly, was followed by intense amblyopia. An examination showed that the visual field had decreased both on the right and left sides, but to a greater extent on the former than on the latter, and that there was, in addition, an intense dichromatism for the blue and red primary colours. An external examination revealed nothing worthy of note; in the mouth no pathologic lesion could be seen.

The author's conclusions regarding the peculiarities of this case are that the amblyopia was not of reflex nature; that the dichromatism was an interesting feature of the case by virtue of the previous occupation of the patient; that the amaurosis and the dichromatism confirm the fact observed by Trombetta, viz., that the symptoms exhibited by those affected with traumatic neurosis become in preference localized in those organs which for each patient are of pre-eminent importance in his daily occupation; that the nature of the traumatism was entirely out of proportion to the severity of the consecutive neurotic manifestations; that even the most insignificant stimuli may be followed by serious and unexpected consequences in the case of neuropathic patients.

Glaucoma.—In referring to convergent strabismus it was pointed out that the irritation from eruption might in some cases be the determining cause; in like manner it is possible that odontalgia may be the determining cause of a glaucoma. If an eye is anatomically in a condition favourable for the onset of an attack of glaucoma, severe pain arising from a carious tooth may so lower the vitality of the patient that the disease may be started. Von Hippel and Grünhagen[1] consider that irritation of the fifth nerve raises the intra-ocular pressure. Priestley Smith's[2] experiments, however, seem to show that the tension is not increased in odontalgia.

[1] *Arch. f. Ophthal.*, xiv, 1, p. 107.
[2] Priestley Smith, "Glaucoma," London, 1879.

CHAPTER XXVII

The Operation of Extraction of the Teeth

The General Principles of Extraction—Extraction of Individual Teeth and Roots—Extraction of Misplaced Teeth—Extraction of Teeth under Anæsthetics—Difficulties, Complications and Sequelæ of Extraction of Teeth

Extraction is an operation which requires skill, judgment, experience, and an accurate anatomical knowledge of the parts involved. As with all other manipulative proceedings, success can only be attained by actual practice.

(A) THE GENERAL PRINCIPLES OF EXTRACTION

The tooth to be removed should be carefully examined in order that the operator may gain some idea of the amount of sound tissue present and the degree of force which will be necessary to dislodge the tooth. In the case of roots the edges must be defined, and for this purpose a blunt probe will be found useful.

(1) Instruments

The instruments in general use for the removal of teeth are forceps and elevators.

The forceps is an amplified pair of pincers or pliers. It is made up of three parts, namely, the blades or portions beyond the joint which are applied to the tooth, the joint itself, and the handles. Forceps should be made of fine steel, light, and yet strong enough to withstand without bending any strain that it may be necessary to put upon them. The blades should be shaped to fit the tooth they are intended to remove, and when applied they should be clear of the crown. On longitudinal section a blade should present a thin wedge-shaped appearance.

The handles should be of a size and shape to lie comfortably in the palm of the hand and should be in such relation to the blades that when the blades are applied in the direction of the long axis of the tooth the handles are clear of the lips.

As a general rule, in forceps designed for the removal of the anterior teeth of the maxilla, the blades and handles are in the same line (fig. 796), while for the upper back teeth the handles form a curve of greater or less extent with the blades (fig. 797). In forceps for the mandibular teeth the blades are bent down from the handles to an angle of nearly ninety degrees. In one class, named the "hawk's bill," when the blades are applied to the tooth the

Fig. 796.

Fig. 797.

handles are at right angles to the line of the arch (fig. 798), while in other classes the handles are in line with the arch (fig. 799). Forceps with aseptic or readily cleansable joints have been introduced.

The elevator consists of two parts—the handle and the blade. The former is about four inches in length and of a shape suitable to allow a firm grip to be obtained. The blade is of fine steel and about two inches long. Elevators are of two varieties, straight and curved. In the straight variety, the blade is thin, about one-fifth of an inch in breadth, one surface being made convex and the other flat. The

For the use of the blocks illustrating the various instruments I am indebted to Messrs. Claudius Ash, Sons & Co.

point of the blade should be rounded as shown in fig. 803. In the curved variety, the terminal half-inch of the steel part of the instrument is bent at an angle with the shaft of the instrument (fig. 823). The edge of the blade of an elevator should always be kept sharp.

The screw (fig. 804) is an instrument which on rare occasions is useful for the removal of deep-seated roots.

After being used, instruments of every kind should be freed from all foreign matter and then carefully sterilized.

FIG. 798. FIG. 799.

(2) Method of Holding Instruments

The manner of holding *forceps* is shown in figs. 800 to 802. The handles should rest comfortably on the palmar surface of the hand, and in such a manner that the end of one handle rests between the thenar and hypothenar eminences—a portion of the hand where force can be applied with the greatest advantage.

The thumb placed between the handles acts as a regulator to control the pressure of the blades upon the tooth. As a precaution it is well to have the ball of the thumb well between the handles, so that the pressure is counteracted by the terminal bony phalanx

of the thumb as well as by the soft tissues. If this precaution be not observed, any sudden crushing of the tooth may be accompanied by a severe and very painful contusion of the operator's thumb.

The method of holding an *elevator* is shown in fig. 805. The handle should rest comfortably in the hand, the first finger lying along the blade and being brought near the point so as to prevent the instrument from slipping. When the elevator is being used for the removal of teeth on the right side of the mandible, the first

Fig. 800.—Mode of holding forceps for the removal of maxillary teeth.

Fig. 801.—Mode of holding lower "hawk's bill" pattern forceps.

finger should lie along the curved side of the blade; and on the flat side when extracting teeth on the left side.

(3) Position of the Operator and the Patient

The chair should be placed before a good light, and, if a proper dental chair is not available, an ordinary armchair may be utilized. The patient should be placed in an unconstrained position, but in such a position as will allow the operator all the freedom of movement which he may require.

The operator should place himself in such a position as to be able to use force to the greatest advantage. His left arm may be utilized, if necessary, for steadying the movements of the patient's head, while the fingers of the left hand can be employed:—

(*a*) To control the cheek and other soft parts so as to obtain a clear view of the tooth to be extracted and its immediate neighbours.

(*b*) To support the mandible.

FIG. 802.—Mode of holding forceps of pattern shown in fig. 799.

FIG. 803.

(*c*) To grasp the alveolar process in order to gain some idea of the effect of the force employed.

The special positions for the removal of different teeth are described on p. 712.

Fig. 804.

Fig. 805.

(4) Anatomy of the Teeth and Jaws

If the teeth be examined it will be noticed that they are capable of division into:—

(*a*) Teeth with single, round, tapering roots.

(*b*) Teeth with single roots which are more or less irregularly flattened or curved.

(*c*) Teeth with multiple roots.

Under (*a*) are included the maxillary incisors (deciduous and permanent) and the mandibular premolars; (*b*) the mandibular incisors and canines (deciduous and permanent), and the maxillary canines and premolars; (*c*) the maxillary and mandibular molars (deciduous and permanent), and frequently the first maxillary premolars.

The shape of the roots, as we shall subsequently find, has an important bearing upon the manner in which force is to be applied when severing the roots from their attachments. To ensure skilful and successful operations a thorough knowledge of the alveoli of the teeth is necessary, and it is needless to say that this knowledge can only be gained by careful study of the bones (fig. 806). Some idea of the strength of different portions of the alveolar border will thus be obtained, a matter of some moment when force is being applied in the process of removing a tooth from its socket. In the maxilla the points to be specially noted are the thinness of the outer

alveolar wall as compared with the inner, and the prominence of the bone in the region of the third molar. In the mandible, the outer alveolar border is, it will be seen, thinner than the inner, with the exception of that portion in the region of the third and, often, of the second, molar; at the posterior portion of the socket of the third molar the bone is moderately dense.

FIG. 806.[1]

(5) Method of Using Instruments

The operation of tooth extraction when performed with forceps may be divided into three stages[2]:—

(*a*) Adjustment of the forceps to the tooth.

[1] From "The American System of Dentistry."

[2] A description of the form of each tooth, with respect to its bearing upon the construction of forceps for its removal, will be found under the heading B.

(*b*) Destruction of the membranes connecting the tooth with the socket and dilatation of the socket.

(*c*) Removal of the tooth from the socket.

In the initial stage *the first step* is the application of the blades. Care must be taken that the points pass between the gum and the tooth, and also that the blades are applied parallel with the long axis of the root.

As a rule, it is best to apply one blade first on the side of the tooth most obscured from view, and then lightly to close the other upon the opposite side. The blades should then be forcibly pressed upwards or downwards, as the case may be, in the direction of the apex of the root; a slight rotary or wriggling motion will often be found of assistance in the process. This "pressing" movement should be continued until a firm hold of the root has been obtained —a matter of great importance, as the successful removal of the tooth depends in a large measure upon the grip obtained. The handles should next be closed so as to give the blades a firm grip, and the amount of pressure applied should be such that when movement has commenced the blades do not ride upon the surfaces of the root. The amount of pressure must of course depend upon the character of the tooth to be removed, and the resistance offered by the alveolar process. The thumb placed between the handles of the forceps, as already explained, should counteract the pressure on the root and prevent crushing.

The second stage—the destruction of the membranous attachments and dilatation of the socket—is accomplished by employing force in either a rotary or a lateral direction. The movement to be employed depends upon the form of the root or roots to be removed and the resisting strength of the surrounding hard structures. Rotary action is of course admissible only in the case of teeth possessing a single conical root.

The final stage is carried out by exerting extractive force in the direction of the long axis of the tooth, while at the same time following the line of least resistance; the latter is determined by a knowledge of the anatomy of the alveolar border and by the sensation conveyed to the hand through the forceps.

Elevators.—*The removal of a tooth with a straight elevator* is accomplished in the following manner:—

The blade, with the flattened surface towards the tooth to be removed, is inserted between the root and the alveolar process, the instrument being kept as far as possible parallel with the anterior surface of the crown. The blade is then forced downwards so as to reach the root at a point as low as possible; the handle of the

elevator is then rotated away from the direction in which the tooth is to be removed. This has the effect of raising the tooth in its socket and at the same time displacing it in the required direction. One such movement of the instrument rarely suffices for the removal of a tooth, and a second, and sometimes a third grip, each time nearer the apex of the root, has to be obtained.

The method of using *a curved elevator* will be described in dealing with the removal of the roots of mandibular teeth.

The Screw.—Before attempting to remove a deep-seated root with the screw, a good view of the root should be obtained by pressing the overlying tissues away. A clear view of the root canal having been gained, the screw should be carefully worked into the canal, and when sufficient hold has been obtained extractive force should be applied.

(6) The Preparation of the Mouth

The tooth to be extracted should be freed from all foreign matter by the removal of any adherent salivary calculus and the thorough irrigation of the space around the tooth. For the purpose of irrigation peroxide of hydrogen is most useful, and the mouth should also be thoroughly rinsed with a suitable wash. The soft tissues around the tooth to be extracted should be swabbed with a two per cent. solution of iodine in alcohol. When many teeth have to be removed at one sitting every endeavour should be made to render the mouth as aseptic as possible before operating, especially in the case of patients suffering from periodontal disease. It is a good plan to prescribe a mouth-wash to be frequently used for at least one week before removing the teeth. The patient should also irrigate the individual sockets with a suitable antiseptic. By the removal of the sepsis in the mouth the resistance of the tissues is raised and they react more readily to the injury caused by the removal of the teeth.

(7) Character of the Wound

The wound resulting from the removal of a tooth is a lacerated one. It is best treated by keeping the parts carefully cleansed from all foreign matter, and for this purpose an antiseptic mouth-wash[1]

---

[1] The following is a useful formula:—

℞ Liquoris potassæ	... ...	ʒvi.
Acidi carbolici glacialis	... ...	ʒiv.
Aquam	... ...	ad ℥iv.

M. One teaspoonful to be used with half a tumbler-full of warm water as a mouth-wash.

should be used several times a day. On the extraction of a maxillary tooth the discharge from the wound drains away naturally owing to the position of the orifice. The wound caused by the removal of a mandibular tooth cannot drain naturally and, should sepsis be present, the socket must be frequently syringed with some antiseptic solution.

The repair of the wound caused by the extraction of a tooth has never been carefully studied, but there is no reason to suppose that the process differs from that seen in the repair of other bones. The changes in the bone as seen in dried specimens are as follows:—

(1) The margins of the sockets undergo slight absorption (fig. *a*).

(2) The wall of the socket is covered with a layer of fresh cancellous bone which gradually fills up the whole of the cavity (figs. *b*, *c*, *d*).

Fig. 807.

(3) The compact layer forming the outside of the bone gradually spreads over this cancellous layer and eventually forms a complete cover (figs. *e* and *f*).

Where the bone around the teeth has been chronically inflamed, complete regeneration of the compact tissue does not always occur, the surface of the bone being of an irregular character.

(8) Extraction during Pregnancy

In the early months of pregnancy extraction may be performed with safety. After the sixth month the removal of teeth should

be avoided if possible unless they are causing severe pain which cannot be alleviated by any other means. In such cases the teeth should be removed under anæsthesia, as it is important to avoid shock as far as possible.

(9) Extraction during the Menstrual Period

If extraction is rendered necessary through acute suppuration the tooth may be removed at any time during menstruation, but otherwise it is better to wait until the end of the "period."

(10) Extraction of the Deciduous Teeth

Although the methods employed in the extraction of both deciduous and permanent teeth are alike in actual details, there are one or two points connected with the extraction of the deciduous teeth to which attention may with advantage be directed. First, when it is necessary to extract a child's tooth the child must be told. It is an unwise proceeding to deceive children in such matters or take them unawares. The confidence and consent of children can generally be gained after a little practice and by the exercise of moral suasion. It should also be remembered that anæsthetics are quite as needful for the extraction of the deciduous as the permanent teeth, the pain to a child being quite as great as to an adult.

(B) EXTRACTION OF INDIVIDUAL TEETH AND ROOTS

(1) Maxillary Teeth

For the removal of teeth in the maxilla the patient should be placed at such a level that the left arm of the operator can, if necessary, embrace the head of the patient with comfort. The operator should stand at the right side of the patient, and slightly in front, the first finger and thumb being placed on either side of the alveolar process (fig. 808). In the event of the patient becoming restless, the arm should be moved so as to encircle the head and hold it firmly.

(*a*) *Maxillary Incisors.*—The roots of the central and lateral incisors are usually cone-shaped, the anterior surface forming the arc of a larger circle than the posterior surface. Forceps for the removal of these teeth ought therefore to have the blades made to correspond to the surfaces. The lateral incisor is smaller than the central, and has at times a root somewhat flattened. In removing maxillary incisors the posterior blade is applied first, care being

taken to see that the edge of the instrument passes between the gum and the tooth. If this fails to dislodge the tooth from its attachments, a firm rotary motion, first to the right and then to the left, may be tried (the amount of rotation necessary being only about an eighth of the circle represented by the circumference of the root). To dislodge these teeth a firm inward movement should be made in a direction towards the palate, this movement being followed by one in an outward direction.

It is usually recommended that, in the first instance, rotation should be tried for the extraction of these teeth, but the teeth yield more readily and with less laceration of the soft tissues if the inward movement is adopted.

Fig. 808.

The extraction of the roots of these teeth does not, as a rule, present much difficulty. When the roots are moderately sound the instrument shown in fig. 809 may be used, but where the root is much decayed and lies well below the gum margin, a rather finer pair will be found more serviceable. The manner of removal is similar to that used when the crown is standing.

(*b*) *Canines.*—These teeth, like the incisors, are single-rooted, the difference between the curve of the anterior and posterior surfaces is greater in the canines than in the incisors. The roots, too, are much longer than the incisor roots, more firmly implanted, and hence require more force in their removal.

Forceps similar in pattern to those employed for incisors may be

used, the severance of the tooth from its attachments being brought about by force applied in an inward, followed by an outward, direction. The root being more or less three-sided, rotation cannot well be adopted. The root of a canine tooth should be removed in the same manner as the whole tooth.

(*c*) *Premolars.—The first premolar* has usually one root flattened and more or less longitudinally grooved on its mesial and distal surfaces. If this grooving is very pronounced, the result is that the root is more or less divided into two slender terminations. The existence of such bifurcation can seldom be determined before operation, and would not alter the method adopted, but the tendency

Fig. 809.

to this variation should be borne in mind and the lateral movement should be made very cautiously. The internal and external surfaces of the root are, for all practical purposes, of equal curvature.

The second premolar has usually only one root, which is not so flattened in the anteroposterior diameter as in the first premolar, and the grooving and bifurcation of the root is less in the second than in the first premolar.

The blades of forceps for the premolars should be equal segments of the same circle; they should also be bent at such an angle with the handles that the handles may clear the lower lip. The forceps

shown in fig. 813 is a useful pattern. In removing a maxillary premolar, the inner blade of the forceps should be applied first. For severing the tooth from its attachments, a slight inward movement should first be made followed by an outward. If the socket does not then yield, the inward movement may again be made and repeated if necessary. The removal of the tooth from its socket is to be carried out by force applied in a downward and outward direction. The removal of premolar roots is carried out in a manner similar to that of the whole tooth.

For the removal of unerupted premolars see p. 211.

FIG. 810.

(*d*) *Molars.—The first molar* has three roots, one internal towards the palate (palatine), and two external (buccal); of the three, the palatine is the largest; it is subcylindrical in form, and often curved. The two buccal roots are placed one in an anterior and the other in a posterior position, the latter being in a plane internal to the anterior root; both these roots are somewhat flattened, and, of the two, the anterior is the larger. The roots of the *second molar* are similar in shape to the first, but are usually smaller.

The third molar, when normal, has three roots, but very frequently these are all fused together and form an abrupt tapering

cone, the point of which is often curved. Owing to the disposition of the roots, different forceps will be required for the removal of upper molars on the right and left sides. Of the blades, the outer

FIG. 811.—(*a*) normal maxillary first permanent molar; (*b*) oblique-rooted maxillary first permanent molar; (*c*) normal maxillary second permanent molar; (*d*) oblique-rooted second permanent molar.

or buccal should possess two grooves, the anterior being the broader and placed in a more external plane. This blade should also have a slight projection between the grooved surfaces to adapt itself to the space between the buccal roots. The inner or palatal blade should possess only one groove. A well-made pair of upper molar

FIG. 812.

forceps should fit the neck of a maxillary first permanent molar perfectly. The blades should be bent at an angle with the handles, so that when in use the latter may be clear of the lower lip (fig. 810). The palatine blade should be applied first, and in bringing the outer

blade into place the point should be kept over the groove on the buccal side of the tooth, as this groove is a guide to the space between the outer roots. To sever these teeth from their attachments, force must be applied, first slightly inwards and then outwards, the movement being repeated if necessary, the removal of the tooth from the socket being carried out by exerting force in a downward and outward direction. Too much outward movement leads to undue bending or fracture of the external alveolar plate.

In removing the third molars it is advisable not to have the patient's mouth opened to the fullest extent, as the tension of the tissues of the cheek will thereby be lessened, thus giving a clearer view of the outer side of the tooth. The correct application of the forceps is of the utmost importance, as there is danger of including some of the soft tissue between the blades and the tooth and so causing a painful laceration. Force applied inwards, then outwards, is generally sufficient to loosen these teeth, their removal being carried out by a downward and outward movement.

Forceps similar to those in fig. 810 may be used for the removal of the third molars, but most operators use patterns the blades of which are similar segments of the same circle. *There is an abnormality of the maxillary molars* which may with advantage be mentioned here. It consists in the posterior buccal root being situated in a plane much internal to the anterior root—in other words, it is an exaggeration of the normal arrangement. Such teeth are termed "*oblique-rooted*" (fig. 811). This abnormality is met with most frequently in the third molar, sometimes in the second, rarely in the first. The difficulty encountered in extracting these teeth is that the outer blade of the forceps is apt to slip round. Oblique-rooted teeth can at times be diagnosed by noting an undue prominence of the alveolar process over the anterior buccal root; such teeth are best removed with forceps similar to that shown in fig. 812.

Where a portion of the crown remains and caries has extended well below the gum on either the palatal or buccal side, ordinary molar forceps should be discarded and root forceps employed; useful patterns are shown in figs. 813 and 814. The removal of teeth in this condition is carried out as follows: It will be supposed that the decay extends deeply on the palatine side. One blade of the forceps should be first applied to the buccal side of the tooth and to the root which is considered the stronger; the inner blade should then be applied to the palatine root, care being taken to insinuate it between the alveolus and the root. The forceps should be pushed well upwards until a firm hold of the root is obtained. A firm

inward movement should then be made, as this will allow the inner blade to pass still higher up the palatine root and ensure steadiness should the blades tend to ride upon the surface of the root. An outward movement should next be made, but far less than that used in extracting molars with the whole of the crown standing. This inward and outward movement is to be repeated until the tooth is free, the force being principally applied in the inward direction.

When the more extensive decay has taken place on the buccal side the order of procedure is slightly different. The first blade to be applied should be the palatine, the outer blade being closed upon

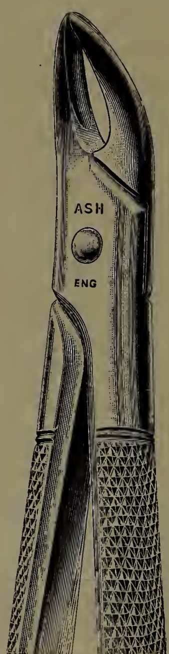

Fig. 813.

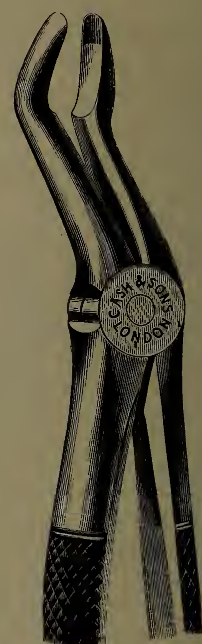

Fig. 814.

whichever of the buccal roots is considered the stronger. The extractive force should be applied first outwards and then inwards, these movements being repeated if necessary, the principal force being outwards, as the object in view is to prevent the instrument from slipping off the more decayed side.

When a molar is so carious that very little of the crown remains, but all the roots are still united, root forceps should be used. The inner blade should be applied to the palatine root first, the outer blade being closed upon the stronger of the buccal roots. Inward, followed by outward, movement should be employed, the point to

bear in mind being to use force towards the side of the tooth which is considered to be the weaker. In the majority of such cases the three roots come away together, but even if this does not happen, one or perhaps two will be removed and the remainder can be removed later without much difficulty.

Where the resistance presented by the roots is very great and an unsuccessful attempt at removal has been made with ordinary root forceps, an instrument with a buccal blade similar to that shown in fig. 815 may be used. The inner blade is applied first,

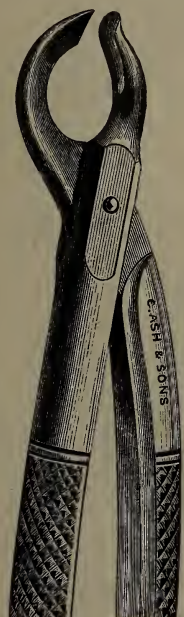

Fig. 815.

the outer being inserted, if possible, into the space between the buccal roots. A firm hold of the roots having been gained, extraction should be attempted by force applied in an inward and outward direction; this failing, sufficient pressure should be put upon the handles to split the roots asunder. The sharp outer blade of the forceps will then pass between the buccal roots on to the palatine root which can thus readily be brought away. A pair of ordinary upper root forceps should be employed to remove the buccal roots.

If all three roots of a molar are separate, a slight rotary movement will usually suffice for their removal.

Where there is danger of a molar fracturing, root forceps should be used in preference to ordinary forceps.

(2) Mandibular Teeth

For the removal of mandibular teeth the patient should be placed on a low level, the head being kept a little forward and the chin depressed. The position of the operator will depend upon the tooth to be removed and the instrument to be used. With teeth on the right side, when hawk's bill pattern forceps or elevators are used, the operator should stand behind and to the right of the patient, the left arm being brought round the patient's head. The thumb of the left hand should be placed on the inside and the first finger on the outer side of the alveolar process of the tooth to be removed, and the three remaining fingers under and supporting the chin. In placing the fingers in the mouth, care should be taken to keep the wrist well down so as not to impede the entrance of light (fig. 816).

Fig. 816.

When removing the anterior teeth or those on the left side of the mouth, the operator should stand on the right side and slightly in front of the patient. The left hand should be placed as follows: the second finger on the lingual side, and the first on the labial side of the alveolar process of the tooth to be extracted, the thumb being placed under the chin (fig. 817). When employing forceps of the straight pattern shown in fig. 821, the operator should stand as shown in fig. 817, but it will be found difficult to place the fingers of the left hand on either side of the alveolus; indeed, they can only

be used with advantage for retracting the cheek and supporting the mandible.

In removing teeth from the mandible, the operator should be careful to guard against the sudden separation of the tooth from its attachments when raising the tooth from its socket, as, unless the instrument is well under control, damage may be caused to the upper teeth.

(*a*) *Incisors.*—These teeth have each a single root, which is much flattened laterally. For their removal, forceps similar to those

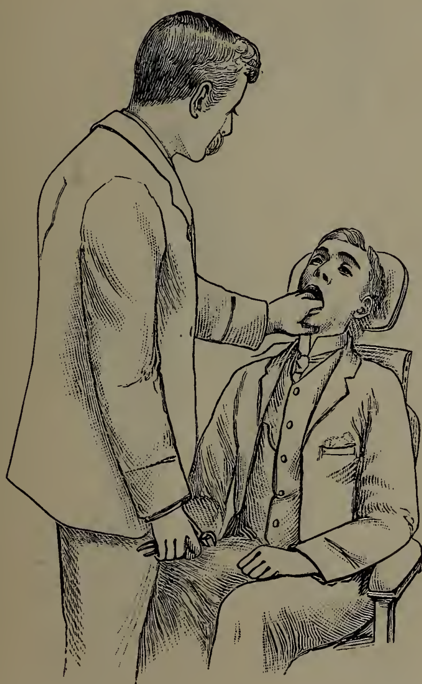

Fig. 817.

shown in fig. 818 should be used, the blades being equal segments of the same circle. The lingual blade should be applied first, the loosening movement being made by taking the tooth slightly inwards and then outwards, the final extractive force being upwards and outwards.

The removal of mandibular incisor roots is carried out in a similar manner.

(*b*) *Canines.*—The mandibular canines have normally one root, which is flattened laterally. It is stronger and longer than the

incisor roots. The removal of a mandibular canine is carried out in a manner similar to that employed for the removal of a mandibular incisor, but as the canines present more resistance than the incisors greater force is usually required.

(c) *Premolars.*—The lower premolars have normally one root, which is conical in shape. In the first premolar the conical shape of the root is not so marked as in the second, the outer aspect being the arc of rather a larger circle than the posterior. Forceps similar to those shown in fig. 818 may be used, the blades being practically

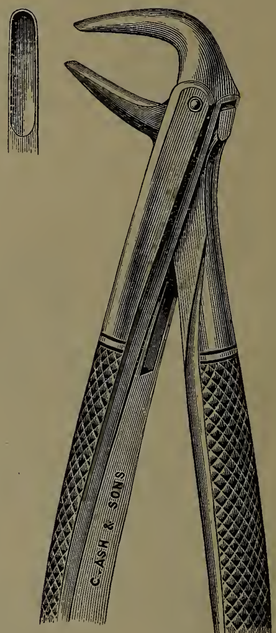

FIG. 818.

equal in size and shape. The lingual blade of the instrument should be applied first, the tooth being severed from its attachments by a slight rotatory movement around the long axis of the tooth, first in one direction, then in the other; should this not suffice, a slight inward followed by an outward movement may be tried, the tooth being raised from its socket by force applied in an upward and slightly outward direction.

The roots of mandibular premolars should be removed in a manner similar to that required for the extraction of the whole tooth. When the root lies much below the level of the gum, the extraction is often troublesome owing to the difficulty in gaining a hold with the blades of the forceps; in such cases, if an attempt with forceps has failed, the straight elevator may be employed.

(*d*) *Molars*.—Mandibular molars have two roots, placed anteriorly and posteriorly. The roots are much flattened, and have a tendency to curve backwards, the curving being well marked in the second and still more so in the third molar; a fusion of the two roots is at times met with in the second and, frequently, in the third molar.

Fig. 819.

A section of a lower molar at the neck shows both the buccal and lingual surfaces to be composed of two segments of a circle touching each other at one extremity, the anterior segment being slightly the larger (fig. 819). Each blade of the forceps used for these teeth should possess two grooves separated by a projection which fits into

Fig. 820.

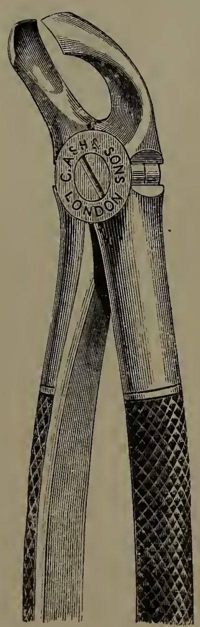

Fig. 821.

the division between the anterior and posterior roots; for all practical purposes the blades may be made of the same size, so that one instrument will suffice for both sides of the jaw. The instrument best adapted for the removal of these teeth is shown in fig. 820, though some operators prefer the shape illustrated in fig. 821. The

advantages of the former over the latter may be briefly summed up as follows: (1) A clear view of the tooth and its surroundings can be obtained during the whole period of removal; (2) force can be applied with greater advantage; (3) the alveolar process can be easily embraced by the fingers, or by the finger and thumb of the left hand.

One disadvantage of the shape shown in fig. 820 is the difficulty of employing much inward movement, and therefore, for teeth lying inwards, that is, with the crown directed towards the tongue, hawk's bill-shaped forceps cannot be easily used. Another disadvantage is that the extent of inward movement is limited by the proximity of the maxillary teeth, and, in case of trismus, it is often better to use straight forceps.

In removing mandibular molars with forceps, the inner blade should be applied first and then the outer, care being taken to get the points of the blades between the interspaces of the roots. For severing these teeth from their attachments, a slight inward movement should be made first, followed by a movement well outwards, these inward and outward movements being repeated if necessary. The removal of the tooth from its socket is carried out by force used in an upward and outward direction. The upward force exerted upon lower teeth should always be well under control, as, not infrequently, the resistance is overcome very suddenly, and without such precaution there is danger of forcibly striking the upper teeth. As previously pointed out, the roots of these teeth are at times curved a little backwards, and it is often needful, in removing the teeth from their sockets, to twist the forceps in a curved direction backwards.

In the *removal of the second molar*, too much outward movement is to be avoided, as the outer alveolar process is often very dense.

The third molar is best removed with a straight elevator. A glance at the illustration of this tooth (fig. 822) will show that the roots have a well-marked curve backwards, in addition to which the bone forming the socket of this tooth is stronger than is the case with the anterior molars. The removal of the third molar has therefore to be accomplished by using force in a direction upwards and backwards, in other words, in a curve similar to the arc of the circle formed by the roots. This movement cannot well be carried out with forceps, but is easily accomplished with the elevator as follows (it being assumed that the second molar is in place): Hold the elevator as shown in fig. 805, and insert the blade between the anterior surface of the root and the alveolar process,

keeping the flattened side of the instrument as far as possible parallel with the root surface. Then force the blade downwards towards the apex of the root and rotate the handle away from the direction in which the tooth is to be moved. This has the effect of raising the tooth in its socket and at the same time displacing it backwards. (The edge of the elevator which is to be brought into contact with the surface of the root should be sharp so as to cut somewhat into the cementum.) If this movement is not effective the handle should again be raised and the flattened end of the instrument brought parallel with the anterior surface of the root, the extractive movement being repeated until the tooth is completely raised from its socket. In using the elevator, special care

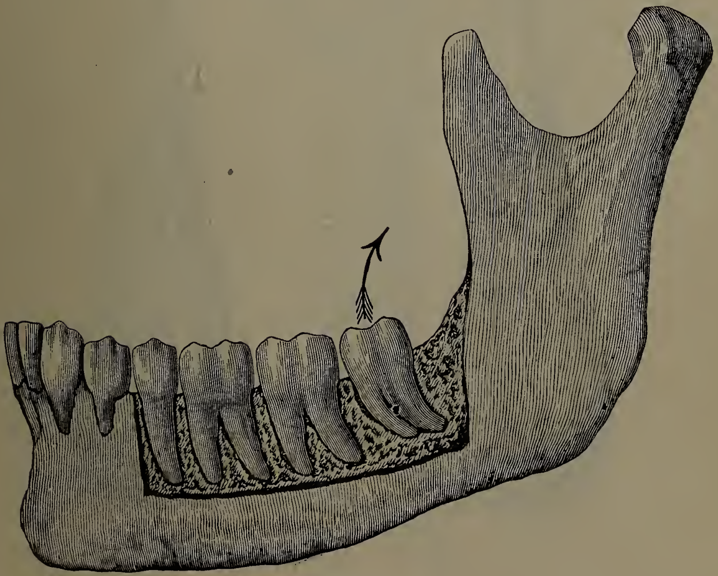

Fig. 822.

must be taken to protect the tongue with the thumb or the fingers of the left hand, so as to provide against the instrument slipping and penetrating the tongue.

With the third molar there is a tendency for the gum to adhere tenaciously to the posterior aspect of the neck of the tooth. When this happens it is better simply to raise the tooth from its socket with the elevator or forceps, as the case may be, and then cut the gum away with a curved pair of scissors. By this method a severe laceration of the gum may at times be avoided.

When the third molar is isolated owing to the absence of the

second molar, the elevator may still be employed for its removal, the first finger of the left hand being used as a fulcrum on the right side and the thumb on the left side. In such cases many operators prefer to use ordinary lower molar forceps.

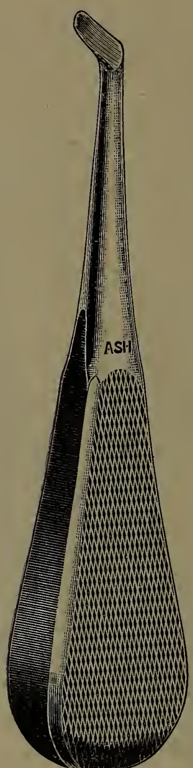

Fig. 823.

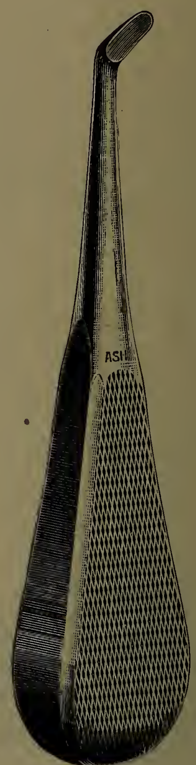

Fig. 824.

The removal of mandibular molars when a portion of the crown is standing, but the caries has progressed below the gum on either the buccal or lingual aspect, is carried out with root forceps of shape shown in fig. 818. A similar condition in maxillary molars and the method of their removal was referred to on p. 717. The principles enumerated there apply to the removal of the lower molars and it is not therefore necessary to repeat them. The main points to bear in mind are to apply the blades of the forceps to the stronger root, and to use the principal force in the direction of the weaker wall.

Where the roots of molars are still united, root forceps should be used, the blade being first applied to the lingual surface of the stronger root. A firm hold having been obtained, the root may be

removed by employing force in the same way as with ordinary molar forceps. Both roots will usually come away together. If only one root is extracted, the remaining root can easily be removed with the same forceps or with a curved elevator (figs. 823 and 824). The curved elevator should be insinuated between the root and the alveolar process so as to force the tooth into the empty socket, or the elevator may be placed in the empty socket and the root elevated by forcing the point through the septum of bone.

With roots of mandibular molars which present great resistance, forceps with cutting blades may be used (fig. 825). The blades are

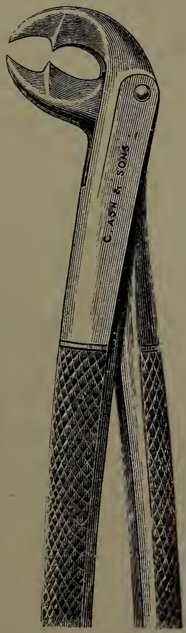

Fig. 825.

inserted on the lingual and buccal aspects of the roots in such a manner that the points pass into the space between the roots. The handles are then closed and an attempt is made to remove the roots in the ordinary way, but, should this prove unsuccessful, the handles must be forcibly closed so as to divide the roots which can then, as a rule, be removed with ordinary root forceps.

The advantage of splitting roots in a case similar to that shown in fig. 826 is apparent, as each root can then be removed in the line of its inclination.

Where the roots are separated their removal is carried out with

root forceps, an inward and outward movement being usually sufficient. The roots of third molars are best removed with a straight elevator. The *modus operandi* is similar to that used in extracting the whole tooth.

At times the mandibular molar teeth are tilted so that the crown surfaces stand towards the tongue. Their removal is best carried out with instruments of the pattern shown in fig. 821, as the handles of forceps of the hawk's bill pattern would come in contact with the

FIG. 826.—(*a*) lower molar with divergent roots; (*b*) the dotted lines show the direction in which the roots can be removed if the tooth is divided as suggested in the text.

upper teeth and impede the inward movement which is so necessary for the removal of teeth in this position.

(3) Deciduous Teeth

For the removal of maxillary incisors and canines, a small pair of straight forceps of the pattern shown in fig. 827 should be used. The first deciduous molars are best removed with a pair of forceps like fig. 828.

The mandibular incisors and canines require a small pair of hawk's bill forceps similar to the shape shown in fig. 818. For the deciduous molars a small pair of forceps similar to that illustrated in fig. 820 should be used.

In removing deciduous teeth, care must be taken not to drive the forceps too high up or the permanent teeth may be injured, and this danger should be specially guarded against in the case of the deciduous molars, as the roots of these teeth practically embrace the crowns of the premolars.

Roots in the condition shown in fig. 829 are best removed with an elevator as follows: The thumb of the right hand being placed on an adjacent tooth so as to gain a hold, the point of the elevator should be placed below the end of the root and pressure applied. In a few cases it may be necessary to cut the gum with a lancet before using the elevator. For the small pieces of the deciduous teeth which persist and become wedged in between the permanent teeth, the small curved elevators will be found useful.

(C) THE EXTRACTION OF MISPLACED TEETH

The extraction of a misplaced or impacted tooth is perhaps the best test of the skill of an operator, and although it is impossible to give a complete list of the various malpositions met with, those most commonly seen will be mentioned and the usual method of removing such teeth indicated.

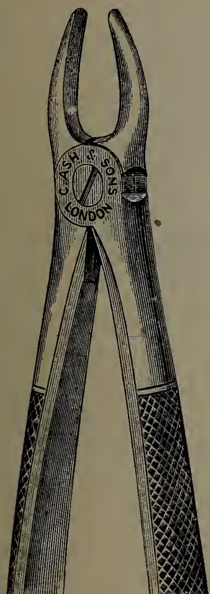

Fig. 827.

Fig. 828.

Fig. 829.[1]

(1) Maxillary Teeth

(*a*) *Central Incisors.*—The extraction of an irregularly placed incisor such as is shown in fig. 830, which is the seat of intractable chronic periodontitis, is best carried out with an instrument similar to that shown in fig. 831, the fine inner blade being applied on the

[1] From "Dental Surgery and Pathology," by A. Coleman.

palatal side and the broad blade on the labial. Extractive force should be applied principally in the outward direction, and, if this is not sufficient, slight rotary movement should be tried. Where

Fig. 830.

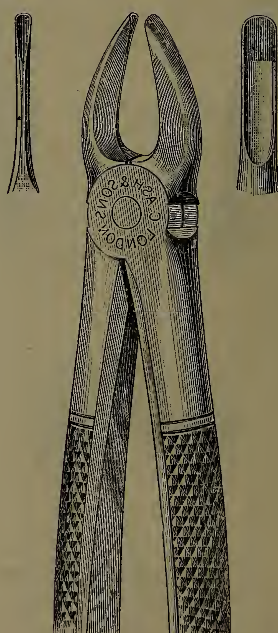

Fig. 831.

there is less room between the approximal teeth, the projecting tooth may be removed with a pair of straight forceps (fig. 809), the blades being applied to the mesial and distal aspects of the root.

The blades should not be driven very far up, and the loosening of the tooth should be accomplished by slight rotary motion, but care should be taken to avoid loosening the approximal teeth.

(*b*) *Lateral incisors* lying internal to the arch, see fig. 832, can be removed with the forceps shown in fig. 831, by placing the

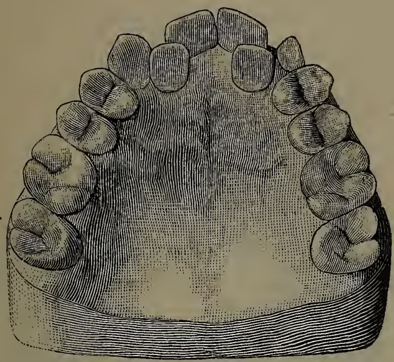

Fig. 832.

fine blade on the labial and the broad blade on the palatal side of the tooth. Extractive movement should be made inwards, followed by very slight outward movement; this failing, rotation should be

Fig. 833.

tried, but, as pointed out on a previous page, this form of movement is not so suitable for lateral incisors as for centrals.

(*c*) *Canines* placed high in the arch, as shown in fig. 833, may be extracted with a straight pair of forceps (fig. 809), the blades being placed on the mesial and labial aspects of the root. Extraction

of such teeth is very difficult. Slight but firm rotation may first be tried; if this fails to loosen the tooth, slight lateral movement may be attempted, the force being applied towards, and then away from, the median line of the mouth.

(*d*) *Premolars* misplaced, as shown in fig. 834, can be removed

FIG. 834.

with forceps similar to those depicted in fig. 813, the blades being applied on the anterior and posterior aspects of the tooth. Force should be applied in a backward and forward direction; the movements being repeated alternately until the tooth is loosened in its socket. A premolar placed as shown in fig. 835 can be removed

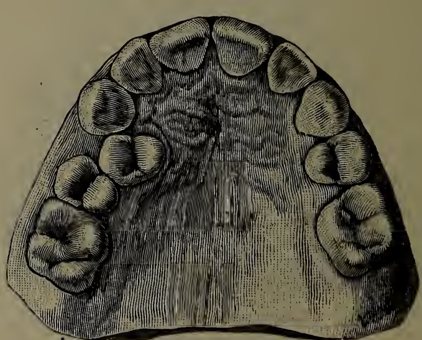

FIG. 835.

with forceps similar in form to those depicted in fig. 813, with the outer blade strong but narrow. The extractive movement should be made mainly in an inward direction.

(2) Mandibular Teeth

(*a*) *Central incisors* misplaced, as shown in fig. 836, may be removed with ordinary lower root forceps (hawk's bill pattern), the blades being placed on the mesial and distal surfaces of the root and movement applied in a direction towards and away from the median line of the mouth. When the crowding is not severe (fig. 837) forceps of the hawk's bill pattern with a strong but narrow

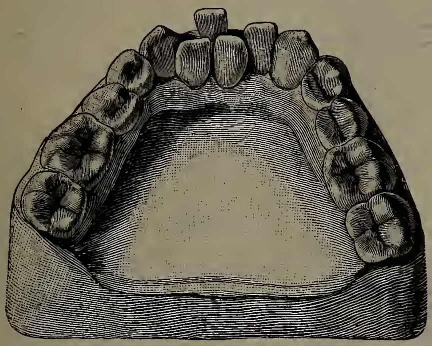

Fig. 836.

inner blade should be used (fig. 839), and the principal extractive movement made in an outward direction. For an incisor placed as shown in fig. 838, the narrow blade should be the outer one (fig. 840), and the principal force should be applied in an inward direction.

(*b*) *Premolars* placed as shown in fig. 841 are most difficult to remove. One of the most useful instruments for their extraction is a pair of upper root forceps (Read's pattern, fig. 813), which

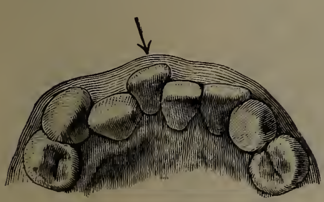

Fig. 837.

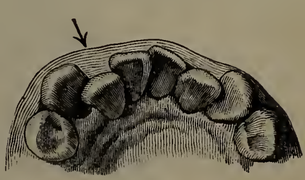

Fig. 838.

should be held so that the curve of the blades is downwards. The blades should grasp the root on its anterior and posterior surfaces. Slight rotary movement may first be attempted, followed by lateral motion. These movements may be persevered with until the tooth is found to yield. Too much haste may lead to a fracture which would be extremely difficult to deal with.

Where the crowding is not very marked and the tooth is more in the normal line of the arch, a forceps with a narrow outer blade will suffice (fig. 840). Extractive force should be used principally

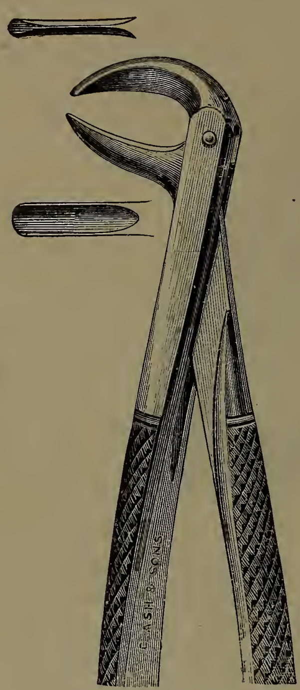

Fig. 839.

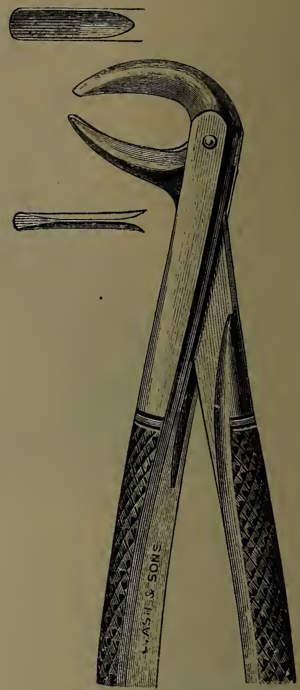

Fig. 840.

Fig. 841.

towards the median line of the mouth, and this may be combined with slight rotary movement.

(c) *Third molars* when *partially erupted or misplaced* are

amongst the most difficult teeth to extract. The position of the misplaced tooth may amount only to a slight tilt forwards, or it may be placed horizontally, the occluding surface of the crown impinging on the posterior root of the second molar. In some instances the teeth may be so placed that the occluding surface looks downwards and inwards. If we examine specimens showing misplaced mandibular molars (see figs. 183 to 185), some points come out very clearly: (1) That the roots of these teeth are to some extent covered by the ramus of the mandible; (2) that the root of the tooth is in close proximity to the mandibular canal; and (3) that only a small amount of bone exists at the posterior aspect of the second molar.

Wherever there is reason to expect difficulty in removing third molars, a skiagram should be obtained in order to ascertain the relation of the tooth to its surroundings.

When the tooth is in a normal direction, but retarded in erupting through want of room in the arch, it is a good plan, before attempting removal, to cut away the overlying gum in order to obtain as clear a view of the tooth as possible. Where the tooth is slightly tilted, the curved elevator will often be found a useful instrument for removal; the blade of this instrument can usually be inserted under the crown and the tooth prised upwards. Where the tooth is firmly embedded in the bone, the muco-periosteum covering the alveolar process should be raised and the bone surrounding the tooth cut away before removal is attempted. The wound left after the removal of the tooth should be syringed regularly until healing is complete. Attempts to remove such teeth by placing a curved elevator under them and forcibly prising them upwards invariably lead to failure, and may, if too much force is used, lead to fracture of the jaw.

(3) Embedded Roots

Roots occasionally become embedded and impacted and a good example of this is shown in fig. 842. The skiagram depicts a lower second premolar impacted between the first premolar and first molar. In cases of this character it is always advisable to obtain a skiagram, and a careful study of it will often be of considerable assistance in deciding upon the method to pursue in attempting removal of these roots. For example, the skiagram seen in fig. 842 shows that the embedded root lies close to the first molar and is separated by a considerable interval from the first premolar. The best instrument for the removal of these roots is a straight elevator, the roots being forced towards the direction of least resistance. In the case described above the elevator should

be inserted between the root and the first molar, and the root elevated towards the first premolar.

Roots lying well below the surface of the bone can often be quite easily removed by means of the screw (fig. 804). The overlying soft tissues should be cut away and the screw worked into the pulp canal of the root until a secure hold is obtained, and then extractive movements applied.

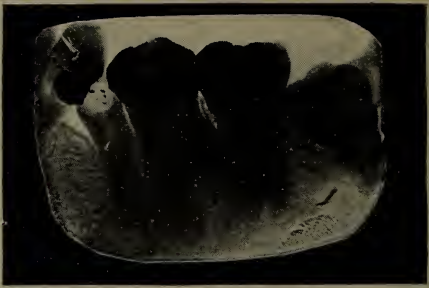

Fig. 842.

(D) THE EXTRACTION OF TEETH UNDER ANÆSTHETICS

The anæsthetics used in connection with the extraction of teeth may be divided into two classes, viz., general and local.

(1) General Anæsthetics

Nitrous Oxide.—For most operations nitrous oxide should be chosen. Provided that asphyxia is avoided nitrous oxide is absolutely safe and has therefore a great advantage over ether and chloroform. Nitrous oxide can be more quickly administered than either ether or chloroform, and the recovery is rapid and complete. The modern practice of administering oxygen or air with nitrous oxide possesses the following distinct advantages over nitrous oxide used alone:—

(i) The danger of asphyxia is lessened.

(ii) The anæsthesia is quieter.

(iii) The congestion of the mucous membrane is lessened, and the operator therefore gains a clearer view of the tooth.

The "nasal method" for the administration of nitrous oxide has been extensively adopted during recent years. By this method the anæsthesia can in some cases be prolonged indefinitely. The nasal method of administering nitrous oxide has advantages over such anæsthetics as ethyl chloride and ether, but considerable experience

and skill are required in the administration; too often an asphyxial rather than a true anæsthetic state is produced. The nasal method is suitable for cases where several loose teeth are to be extracted or where a little extra time is required for the removal of one or two difficult teeth. For powerfully built alcoholics the nasal method is not suitable, and a better result can be obtained by the use of nitrous oxide and oxygen given by the face-piece method.

Ethyl chloride.—For operations requiring one or two minutes anæsthesia, ethyl chloride is a useful agent, especially for children where it is necessary to remove several teeth. It is, however, a dangerous anæsthetic in inexperienced hands.

Ether.—This agent should be employed where a long period of anæsthesia is required. If the patient is thoroughly anæsthetized a period of ten to fifteen minutes anæsthesia can be obtained. The mucous secretion, which is one of the disadvantages in the use of ether in mouth operations, can be lessened by the administration, half an hour before the operation, of an injection in the case of men of morphia $\frac{1}{4}$ gr., atropin $\frac{1}{120}$ gr., in the case of women of morphia $\frac{1}{6}$ gr., atropin $\frac{1}{150}$ gr.

Chloroform.—The employment of this agent in dental surgery is seldom necessary. It is at all times a dangerous anæsthetic and especially for operations in the mouth. A few anæsthetists advocate the administration of chloroform for dental operations in the sitting posture, but the general consensus of opinion favours the horizontal position.

Whenever a general anæsthetic is given for the removal of teeth two persons should always be present, one to concentrate his attention on the administration of the anæsthetic, the other, on the removal of the teeth. It is impossible for one person to operate and at the same time observe the condition of the patient during the anæsthetic period. This rule should be strictly adhered to.

The Preparation of the Patient.—The last meal should be taken at least three hours before the administration of an anæsthetic and the meal should be of a light character. The position of the patient during the induction of anæsthesia and whilst under its influence should differ but little, if at all, from those already advocated except that the head should not be placed so far back. All tight clothing must be loosened; dentures removed from the mouth, and care taken to avoid anything likely to alarm or frighten the patient before and during the induction of anæsthesia. The operator should always decide beforehand precisely what he intends to undertake, and it is wise not to attempt too much. Care should be taken to avoid pricking the gum during the examination of any roots which

are to be extracted. *The prop should be placed on sound firm teeth* in such a position that the operator can work without hindrance, and when the preparations are complete a final view of the mouth should be taken. The prop should be adjusted by the operator as he will know to what extent the mouth must be opened, but at the same time the anæsthetist should see that the position of the prop is not likely to obstruct respiration. *Where several teeth have to be extracted* at one sitting, their order of removal should be decided upon before the operation is commenced, and, if any particular tooth is causing pain, it should be extracted first. As far as possible the *order of removal* should be arranged so that changes of instruments are reduced to a minimum. As a rule lower teeth should be extracted before upper teeth, because if the latter are removed first the blood may pass down and so obscure the lower ones. For the same reason roots should be removed before whole teeth. *Each tooth or root must be cleared from the mouth before any attempt is made to remove another*, unless the gum is thoroughly adherent, when the tooth or root may be left in the mouth and freed from the gum when the patient has recovered.

Special precautions must be taken to prevent the entrance of foreign bodies into the air passages. A sponge or the corner of a napkin should be used for this purpose; they can usually be adjusted in such a way as to give a clear view of the teeth to be removed.

During the operation of extraction, the anæsthetist should—

(i) Hold the head firmly with his hand on the forehead and his shoulder against the patient's head in order to prevent over-extension of the head in which position there is danger of foreign bodies passing into the air passages;

(ii) Protect the lower lip from being pinched between the handles of the forceps and the lower teeth—this is especially liable to occur when the head is over-extended, and

(iii) Clear away blood which interferes with the operator's view.

When several teeth are to be removed on both sides of the mouth, it will be found useful to remove the upper and lower teeth on one side first, and then to cover the wounds with pledgets of wool which should be held in place with the "Mason" gag. By this means the hæmorrhage is held in check during the operation on the opposite side of the mouth.

It has been observed that in extensive dental operations students are inclined to operate with blood flowing freely over the roots that require extraction. Such a practice invariably leads to undue laceration of the gums, and considerably retards the healing of the wounds.

(2) Local Anæsthetics

Local anæsthesia[1] is produced by the injection of certain drugs, and depends for its action upon temporary changes in the chemical composition of the nerves which prevent their conducting sensations to the brain. Local anæsthesia may be used to affect the terminal branches of the nerves only, sub-mucous anæsthesia; or, to interrupt the nerve trunk to either jaw, regional anæsthesia.

The drug usually employed is an alkaloid novocain (para-aminobenzoyl-diethylaminoethanol hydrochloride). It is a white crystalline powder, freely soluble in water, and is readily precipitated by alkaline solutions such as sodium carbonate or lysol—these drugs must not be used in sterilizing fluids for needles or syringes. Novocain is supplied commercially in the form of tablets, the E variety being employed for dental purposes. These contain 0·02 grm. of novocain, and 0·0005 of suprarenin is added to constrict the vessels, thus localizing the drug to the injected area and lessening the chance of toxic effects. One E tablet of novocain to 1 c.c. of normal saline solution makes a· 2 per cent. solution. Three tablets constitute a maximum dose, which is thus 0·06 grm., which is equal to 1 gr. of the apothecary's measure.

A washerless metal syringe with a vulcanite plunger should be employed, the plunger being slightly vaselined before boiling to ensure smooth working; a short nozzle, bayonet attachment, and two varieties of needle, one 2 cm. long, and one 4 cm. long. A test-tube graduated in cubic centimetres and a porcelain dappin mug are also required. These must all be boiled in plain water. While they are boiling, dry the area where the needle is to be inserted and paint this and the area of operation with a 6 per cent. solution of iodine. Make the solution, pour it into the dappin mug, draw it into the syringe, screw on the nozzle and needle, turn it point upwards, tap the barrel, and make sure that all the air is driven from the syringe. Then insert the needle to the region of the nerve with a quick sure thrust, and slowly inject the fluid.

For submucous anæsthesia employ the short needle, passing it into the gum immediately above or below the apex of the root of the tooth to be anæsthetized, upon its buccal and lingual aspects. This method may be used for all the maxillary teeth and for the incisors, canines and premolars in the mandible. For mandibular molars, or where many teeth are to be operated upon in either jaw, regional anæsthesia is utilized.

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[1] I am much indebted to Mr. F. N. Doubleday for the following account of local anæsthesia.

For maxillary regional anæsthesia use the bayonet attachment and short needle. Palpate the posterior margin of the zygoma and insert the needle behind this, as nearly as possible in line with the third molar, and push it into its full length, upwards and inwards, behind the tuberosity of the maxilla.

To catch the inferior dental nerve of the left side, let the patient open the mouth as widely as possible, put the barrel of the syringe into the right angle of the lips, thrust the needle through the pillar of the fauces on the left side, and so backwards for half its length between the internal pterygoid muscle and the inner aspect of the ramus of the mandible. For the right nerve the technique is reversed. In all cases the injecting surface of the needle should point towards the nerve to be anæsthetized. Submucous anæsthesia ensues in two minutes, regional anæsthesia in fifteen minutes, if properly done.

Complications will generally be avoided by strict attention to asepsis and by only using freshly prepared solutions. Discoloured tablets must always be rejected. Proprietary preparations of all kinds should never be used. Some patients get a transient faintness from fright; it is to be overcome by kindness and firmness. The needle may enter a vein; if so the fluid runs from the needle very easily; on withdrawing the needle blood flows from the wound, which is not the case otherwise; make the injection at a slightly different spot, but never continue injecting into a vein; serious toxic symptoms will occur if you do, and the early ones are as follows: blueness of the lips, pallor and sweating of the face, and a rapid pulse of poor tension. If these occur at once boil a tablet of strychnine sulphate grm. 0·0022 in 1 c.c. of water and inject it under the mucous membrane of the cheek. If the patient is known to have a poorly acting heart muscle mix the strychnine with the primary injection. If the patient has a high blood pressure, as occurs in alcoholics, heavy smokers, and large meat eaters, and those who have done heavy manual labour, lower the blood pressure by breaking an ampoule containing amyl nitrate ♏ iii under their nose before giving the novocain injection which contains adrenalin. After an extraction always see that the socket has filled with blood clot. If it has not scrape it with a sharp, newly boiled excavator until it is well filled with blood. Always remember that the object of the injection is to bring the anæsthetic solution into the immediate neighbourhood of the nerve. If you rasp the periosteum or inject solutions into tense tissues under considerable pressure the vitality of the local tissue cells is seriously lowered, then infection may follow and sloughing or necrosis ensue. If an injection is required

in connection with an abscess always choose a site for the insertion of the needle where it will pass through healthy tissue only. By blocking the nerve nearer to the brain than the site of the lesion perfectly satisfactory anæsthesia will ensue, but the injection must not be made where there is a risk of carrying infection into the tissues.

(E) DIFFICULTIES, COMPLICATIONS AND SEQUELÆ OF EXTRACTION OF THE TEETH

(1) Difficulties, Complications and Sequelæ connected with the Teeth themselves

(*a*) *Undue Resistance of the Teeth and Alveolar Process.*—Certain teeth offer more than ordinary resistance to removal. The teeth of persons of strong physique are nearly always very firmly fixed. Isolated teeth also are always more firmly fixed than those in series, a circumstance which is explained by the fact that consolidation of the surrounding bone has taken place. With experience and observation the teeth which are likely to be specially resistant can to some extent be recognized. When undue resistance is encountered, steady and repeated attempts should be made to free the tooth by moving it slightly in different directions; too much force used in one direction would be certain to fracture the tooth or the alveolar process. It may even be found impossible to remove a tooth, in which case it is advisable to dismiss the patient and make an attempt two or three days later when the tooth will probably be loose, as a result of the inflammatory process set up by the previous attempts at extraction, and it can then be easily removed.

The causes of undue resistance are:—

(i) Abnormal density of the alveolar process.

(ii) Divergent and twisted roots.

(iii) Alteration in the shapes of the roots brought about by periodontal inflammation.

(*b*) *Fracture of the Tooth.*—The principal causes of this accident are:—

(i) The use of forceps which do not accurately fit the tooth.

(ii) The use of unnecessary or wrongly applied force in an attempt to loosen the tooth in its socket.

If a tooth has been fractured, the patient should be made to rinse the mouth until the bleeding has ceased; the socket should be dried with cotton-wool, and the position and edge of the root defined with a probe before an attempt is made to remove the fractured portion. Neglect of these steps often leads to failure to remove

the remaining portion of a fractured root. As a general rule more than two attempts to remove a fractured root should not be made at one sitting, and if the second attempt prove fruitless, the patient should be dismissed and a fresh attempt made after a period of one or two days, as the tooth will probably then be looser; moreover, the hæmorrhage will have ceased and it will be possible to obtain a clearer view of the root. Before dismissing the patient an anodyne mouth-wash should be prescribed, and the pulp, if exposed, touched with a strong escharotic. The lower third of a root may generally be left without fear of harm; but it is always advisable to inform the patient when any portion of a tooth is allowed to remain in the jaw, as such knowledge may be of assistance should any trouble arise at a subsequent date.

(*c*) *Crowded and Irregular Teeth.*—The removal of these has already been referred to on p. 729.

(*d*) *The Removal of the Wrong Tooth.*—Should the operator accidentally remove the wrong tooth, it must be immediately replaced and, if necessary, secured with a ligature. If the pulp subsequently shows signs of degeneration or inflammation, it should be removed and the canal treated and filled.

(*e*) *Dislocation of a Neighbouring Tooth.*—This accident, which is generally due to a crowded arrangement of the teeth, seems to occur most frequently with the removal of the first permanent mandibular molar, the neighbouring tooth usually involved being the second premolar, which is simultaneously dislocated from its socket. To avoid this contingency the thumb should be placed on the tooth which shows a tendency to move, and in the removal of the tooth which is being extracted only as much force should be exerted as can be controlled by the thumb. If a neighbouring tooth is removed, it must be replaced and treated in the manner described above.

(*f*) *Removal of an Unerupted Premolar.*—This may be an avoidable or an unavoidable accident. At times the developing premolar is so firmly embraced by the roots of the deciduous molar that, during the extraction of the latter tooth, the premolar is removed; such an accident cannot be avoided. It is an avoidable accident when it occurs through using too much force in the extraction of the roots of a deciduous molar.

In quite young children the tooth sac of the premolar may be so firmly attached to the deciduous molar that its removal is unavoidable.

(*g*) *Breaking One Tooth in Extracting Another.*—In the extraction of mandibular teeth with hawk's bill forceps the maxillary

teeth may be fractured. This accident is generally due to inexperience, and arises from the tooth leaving its socket suddenly owing to the extracting force being used in an upward rather than an outward direction. It may, however, occur when a lower tooth has been more than normally resistant. It is well, therefore, for the operator to be on guard by keeping the thumb or a finger of the left hand over the joint of the forceps. An adjacent tooth may also be fractured in using the elevator.

(2) Difficulties, Complications and Sequelæ connected with the Jaws

(*a*) *Fracture.*—Accidental fracture and removal of a *small piece of the alveolar process* is not uncommon, but the result is not serious. It is sometimes unavoidable, but it may be due to placing the blades of the forceps on the outer side of the bone instead of between the bone and the root of the tooth.

Extensive fracture is sometimes seen; for instance, in a case that came under notice at the Royal Dental Hospital, an unqualified person in removing the mandibular right first permanent molar fractured the bone in a horizontal direction, so that the second and first premolars with the canine were completely separated from the body of the bone. Fracture of the maxillary tuberosity may occur during the removal of the third molar, and Main Nicol[1] records such an accident during the removal of the second permanent molar. An example of severe fracture is recorded by Cattlin,[2] where, in an attempt to remove a maxillary third molar with an elevator, the tuberosity of the maxilla, a portion of the floor of the maxillary sinus and part of the sphenoid were fractured. Direct transverse fracture of the horizontal ramus of the mandible due to extraction of the teeth has also been recorded. In a case recorded by J. H. Badcock[3] a fracture involving the ramus occurred during an attempt to remove a misplaced third molar.

(*b*) *Necrosis* of the alveolar process may result from extraction and is generally caused by undue violence or by the occurrence in the wound of some septic process. For treatment see chapter XXX.

(*c*) *Dislocation of the temporo-mandibular articulation.*—The use of too much force in extracting a mandibular tooth may lead to unilateral or bilateral dislocation of the temporo-mandibular articulation, if the force is not counteracted. This accident may

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[1] *Trans. Odonto. Soc.*, vol. xxviii, p. 3.
[2] *Trans. Odonto. Soc.*, vol. iii., p. 138.
[3] *Trans. Odonto. Soc.*, vol. xxxv, p. 229.

also be brought about by forcing the mouth open too wide with a Mason's gag during the administration of an anæsthetic. Or it may occur without the employment of undue force where the articulation has been previously dislocated. Dislocation of the jaw can easily be reduced by placing the thumbs on the molar teeth, the fingers being placed beneath the chin. A downward movement is to be used with the thumbs and an upward with the fingers. It is well to wrap some lint or a towel round the thumbs to prevent them being injured. If necessary, the leverage can be increased by placing corks or some similar wedge between the molars.

(*d*) *Opening the Maxillary Sinus.*—This accident may occur during the removal of the upper molar, or, occasionally, the second premolar, and may be due to a portion of the floor of the cavity adhering to the teeth, or to the fact that the root of the tooth has only been separated from the sinus by its lining membrane which has been torn away during extraction. The condition is recognized by epistaxis and by fluid passing from the mouth into the nasal fossa via the sinus. The condition usually does not call for treatment unless the opening persists, a circumstance which is extremely rare.

(*e*) *Forcing a Root into the Maxillary Sinus.*—This occurs mostly in connection with the extraction of the maxillary second premolar root and buccal roots of the first permanent molar. If a root has been dislocated into the cavity but partly remains in its socket, it should be left alone, as any attempt to remove it might only result in complete dislocation of the root into the sinus. The socket should be kept quite clean by the continual use of antiseptic washes. When a root has been forced completely into the maxillary sinus, the opening into the sinus should be enlarged and the cavity thoroughly syringed. For this purpose it is well to use an aural syringe of 5 or 6 oz. capacity. The *rationale* of this form of treatment is that the root may pass out with the return current from the sinus. If this treatment fails, free access to the cavity must be gained by an opening through the canine fossa, when the tooth can be easily removed.

(*f*) *Forcing a Tooth into an Abscess Cavity.*—This accident should be treated in the same way as the accident under (*c*).

(*g*) *Trismus.*—Inability to open the mouth obviously renders extraction of the teeth more difficult than usual. When the closure is the result of inflammatory trouble in connection with the lower molars, an anæsthetic should be given and the mouth opened forcibly with a Mason's gag. If the trismus is the result of tonic contraction of the muscles, ether should be used in order to over-

come the resistance of the muscles, as nitrous oxide would not have the desired effect.

(3) Difficulties, Complications and Sequelæ connected with the Soft Tissues

(*a*) *Extensive Laceration of the Gum.*—The soft tissues naturally suffer when a tooth has been difficult to remove, and may be severely lacerated when the gum is more than usually adherent to a tooth. This complication is most frequently seen in connection with the removal of the mandibular third molar, but it is also sometimes met with in connection with the removal of loose teeth. When the gum is more than usually adherent, the tooth should be left in the socket until the gum attachment has been divided with a pair of scissors, or with a lancet. Continued attempts to remove the tooth with the forceps before the gum has been detached will only increase the laceration. Where the gums have been badly lacerated, an anodyne mouth-wash should be prescribed.

(*b*) *Wounding the Tongue.*—This is most likely to occur under nitrous oxide, as the tongue during anæsthesia is generally swollen, and is, moreover, not under the control of the patient. Wounding the tongue is nearly always due to carelessness in the use of the elevator. When the tongue is much lacerated, the overhanging portions should be trimmed off with scissors and the surface kept clean with antiseptic mouth-washes.

If the tongue is punctured and the wound does not involve a large branch of the lingual artery, but yet bleeds freely, the tongue should be drawn forward; if this does not stop the bleeding the insertion of a stitch will generally cause the hæmorrhage to cease.

If the tongue is punctured and a large branch of the lingual artery is involved, the finger should be placed on the back of the tongue and the organ drawn forward, thus compressing the lingual artery against the hyoid bone. The bleeding point must then be sought for, and, if found, an attempt should be made to twist the wounded vessel. If this fails, cauterization may be tried, and, as a last resource, if cauterization does not stop the bleeding, the lingual artery must be tied.

(*c*) *Bruising the Lower Lips.*—This may occur in the removal of premolars and molars, and is due to the mouth being insufficiently opened, and to the use of forceps of too straight a pattern.

(*d*) *Injury of the Mandibular Nerve.*—The mandibular nerve at times runs in close proximity to the roots of the third molar and may be injured during the extraction of that tooth. Occasionally

the nerve pierces the roots of the third molar, and extraction of the tooth then tears the nerve asunder. Montagu F. Hopson possesses a specimen in which the nerve pierced the root of the second premolar. Loss of sensation over the parts supplied by the nerve, with dribbling saliva, generally follows the accident, but sensation is usually restored and if the nerve is lacerated it generally re-unites. On the other hand, there may be no loss of sensation and the pain may be intense.

(*e*) *Suppuration of the Tooth Socket.*—Suppuration in the wound caused by extraction is invariably due to neglect of proper precautions. It is more likely to occur where the vitality of the tissues in the vicinity of the tooth have been lowered, for example, in cases of chronic periodontitis, or where there is a lowered general vitality, as seen in such conditions as diabetes, chronic nephritis, tuberculosis.

Suppuration of the wound may be due to direct infection either from septic foci in the mouth or from the inhalation of air laden with infectious organisms. Suppuration from the latter cause is frequently met with in those constantly working in hospital.

Where the pus is putrid and there is reason to suspect infection, the socket should be thoroughly syringed with some antiseptic, such as carbolic acid 1 in 40, and the parts should be carefully dried with cotton-wool. A small piece of chloride of zinc should then be introduced and allowed to dissolve in the socket, which must be subsequently kept aseptic by constant irrigation with some antiseptic solution. Suppuration occurs more frequently in the mandible than in the maxilla, the drainage of the maxilla being more easily effected owing to the dependent position of the sockets. When suppuration occurs in patients of diminished vitality a tonic form of treatment should be prescribed.

(*f*) *Persistent hæmorrhage following tooth extraction* is a most important complication, and one which needs prompt treatment. Persistent hæmorrhage may be due to:—

(1) Pathological changes in the artery which supplies the tooth, these changes being frequently induced by inflammation around the apex of the root, the vessel becoming adherent to its bony surroundings and thus being prevented from contracting.

(2) A defect in the process of fibrin formation. Fibrin is formed by the action of the fibrin ferment (thrombin) on the fibrinogen contained in the plasma. The formation of thrombin is brought about by the action of a ferment (thrombokinase) on prothrombin, the presence of calcium salts being necessary. The formation of fibrin can therefore be expressed as follows:—

(1) Prothrombin (Thrombogen) (? from leucocytes) + Thrombokinase (from damaged leucocytes or tissue cells) + Calcium salts (in plasma)

Thrombin (fibrin ferment)

(2) Thrombin + Fibrinogen (in plasma)

Fibrin

As regards the condition known as hæmophilia, there is reason to think that the defect lies in the quality of the prothrombin. The blood of these individuals is said to show no abnormality in the quantity of the calcium salts, but it is clinically established that the administration of calcium salts is beneficial, and this fact rather suggests that there is some defect in the calcium content of the blood.

Treatment.—If the hæmorrhage following tooth extraction is at all profuse, it is a useful plan to give the patient some tincture of hamamelis in the water used for rinsing the mouth. Should the bleeding continue, an examination must be made to ascertain (1) whether the bleeding emanates from the gum or from the socket of the tooth; (2) whether the blood shows a tendency to coagulate. If the blood coagulates readily it is probable that the hæmorrhage is due to some condition which prevents the natural contraction of the vessels. If the blood does not coagulate readily the hæmorrhage is probably due to some defect in the process of fibrin formation.

In hæmorrhage from the gum, search should be made for any small vessels that may be the cause of it, and, if found, they should be twisted or compressed. If the vessel is only partially divided, it should be completely severed, as this will probably allow contraction to take place. If the bleeding is capillary in character, a pad of lint applied with firm pressure is usually sufficient to stop it. A method which is efficacious is as follows: With a curved needle in a holder, threads of horsehair are passed through the gum from one side to the other (one usually being sufficient). The ends are then tied tightly, the effect being to exert pressure on the gum and at the same time retain the clot in position.

When the hæmorrhage proceeds from the socket the following mode of procedure is adopted: The socket is first freed from clot, then syringed, then dried out with a pledget of cotton-wool; a thin strip of antiseptic gauze is next firmly packed into the socket, care being taken that the gauze reaches the end of the socket. A plug of lint is then placed over all and kept in position by antagonism with the opposing teeth, a four-tailed bandage being used for this purpose.

If the approximal teeth are standing, an excellent method of keeping the plug in the socket is to wedge a piece of wood between them. But if the hæmorrhage is severe it is better to use the four-tailed bandage to make more certain of retaining the plug in position.

Calcium lactate should be employed, a dose of 60 grains being given, followed by three doses of 15 grains at intervals of four hours (see footnote).[1]

The general directions to be given to the patient, though apparently trivial, are most important and should never be omitted. The patient should be advised to avoid all forms of excitement; to assume the sitting position usual during the day, and to use a high pillow at night. The patient should be fed through a bent tube and all fluids should be given cold.

When the blood coagulates readily, pressure is usually sufficient to arrest the bleeding, but if the blood does not coagulate it is advisable to assist the formation of fibrin by the local application of a preparation of fibrin ferment, a convenient form being "Protagulin."[2] To employ this drug the "protagulin" should be dissolved in normal saline solution and applied to the base of the socket on a pledget of cotton-wool before inserting the plug of gauze.

The patient should be seen within twenty-four hours after treatment, and if the bleeding has ceased the plug may be removed and an antiseptic mouth-wash prescribed; but this course is not recommended when the hæmorrhage has been severe. With severe hæmorrhage the plug should be allowed to remain for two days, and if the hæmorrhage has not then ceased, the socket should be replugged. Should this prove of no avail and the bleeding be from the mandible, the canal should be trephined and a plug of ivory inserted to compress the artery against the inner plate of the bone. In uncontrollable hæmorrhage from the maxilla, digital pressure on the common carotid opposite the transverse process of the sixth cervical vertebra may be tried; should this fail to stop the hæmorrhage, ligature of that vessel must be resorted to. In one case of hæmorrhage from the region of the mandibular right third

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[1] Calcium lactate should be freshly prepared as follows:

Lactic acid	gr. 200
Precipitated chalk	gr. 75
Chloroform water	oz. 8

One ounce equals thirty grains of calcium lactate.

[2] "Protagulin" is prepared by Fannin of Dublin.

molar, Boyd divided the lip in the median line and reflected the cheek from the jaw. The mandibular canal was then laid open by excising the outer plate of the bone, and the bleeding was arrested by plugging the mesial and distal ends of the canal.

In extreme cases with signs of collapse normal saline solution[1] must be infused into the median basilic vein. Cases of death from hæmorrhage following tooth extraction have been reported.

With patients predisposed to hæmorrhage extraction should be avoided if possible; but if the removal of the tooth be absolutely necessary, prophylactic treatment should be pursued for two days before the operation, by the administration of calcium lactate in doses of 15 gr. three times a day. The tooth should be extracted in the early morning, so as to have the whole day for treatment, should hæmorrhage occur. A dose of 60 gr. of calcium lactate should be administered at the time of the operation and the socket plugged at once as a preventive measure, for, be it remembered, it is far easier to prevent the hæmorrhage from occurring than to arrest it when once it has commenced. Should the bleeding prove to be uncontrollable, transfusion of blood from a normal individual must be carried out in order that the substance necessary to produce thrombin may be supplied.

(*g*) *Injury of the Arteries in the Neighbourhood of the Teeth.*—Wound of the lingual artery has been referred to under the heading of Injuries to the Tongue. Laceration of the ranine, anterior and posterior palatine arteries may also occur. Such accidents are usually the result of the forceps slipping and are therefore avoidable.

Treatment consists in pressure, or in twisting or tying the divided vessel. In the case of the anterior or posterior palatine artery it may be found necessary to plug the foramina which give passage to these vessels.

(*h*) *Pain following Tooth Extraction.*—The causes giving rise to pain following the extraction of a tooth are:—

(1) Incomplete extraction of the tooth, more especially when the remaining portion contains an exposed pulp.

(2) Too rapid healing of the orifice of the socket. It sometimes happens that the margins of the wound left after extraction unite very early, and, when this occurs there is no exit for the discharges which naturally come away from the granulating surface at the base of the socket, and the consequence is that they are retained and increase the inflammatory reaction in the surrounding tissues.

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[1] 8·5 parts of sodium chloride in 1,000 parts of sterile water.

(3) Suppuration in the tooth socket.

(4) Extensive laceration of the hard and soft tissues in the neighbourhood of the socket and

(5) Necrosis of the socket of the tooth.

(6) The presence in the wound of a foreign body. A curious example came under notice a few years ago. A patient applied for the extraction of the left first permanent molar. During the operation a portion of one of the cusps disappeared; a search proved fruitless, and the natural supposition was that it had been removed in rinsing the mouth. For the next three weeks the patient complained of slight pain in the socket, for which remedies were tried without success. Eventually the patient discovered the cusp on the top of the granulation tissue which had filled up the socket. In another case of the same character which came under notice the offending material was a piece of an amalgam filling. A fractured blade of forceps may likewise act as the offending body.

(7) Injury to the nerve. Direct injury to the trunk of the nerve is more likely to occur during extraction of the lower third molar than with any other tooth. It is highly probable that many obscure cases of pain following tooth extraction are due to exposure and irritation of the nerve at the apex of the socket. An interesting case of this character was reported by Storer Bennett. The patient, a lady aged 23, had had the maxillary third molar dislocated through the use of a Mason's gag, and as it was considered hopeless to restore the dislocated tooth it was extracted without difficulty. The socket, in spite of treatment, remained painful for the next twelve days, but in the meanwhile granulated healthily, except at its apex, where by the aid of a mirror and probe a spot about the size of a pin's head was noticed, which caused the greatest agony on being touched. Incision of the nerve produced permanent relief.

Where pain follows tooth extraction treatment must obviously depend in a great measure on the cause. A thorough examination of the socket should be made with probe and mirror. When due to incomplete extraction another attempt, if considered advisable, may be made to remove the tooth, and, if this is unsuccessful, the socket should be swabbed with an anodyne drug, and, if there is an exposed pulp in the remaining portion of the tooth, the pulp should be touched with strong carbolic acid. The patient should also be advised to use fomentations.

Where the orifice of the socket heals too rapidly, the freshly healed surfaces must be separated, the socket syringed out, and a small tent of lint allowed to remain in the orifice for about twelve hours. An antiseptic mouth-wash should also be prescribed.

In cases of pain due to necrosis of the socket, deodorant antiseptic injections must be used; while in extensive laceration of the soft and hard parts, an anodyne mouth-wash[1] may be tried. In all obscure cases some local anodyne, such as cocaine, should be applied to the socket, and a mouth-wash having similar properties should at the same time be prescribed.

(*i*) *Traumatic Emphysema.*—A case in which traumatic emphysema followed tooth extraction is recorded by A. Turnbull.[2] A bugler blew his bugle immediately after having had an upper premolar removed, and as a result his face became considerably swollen in consequence of the passage of air through the empty tooth socket into the cellular tissues.

(4) Difficulties, Complications and Sequelæ arising during Extraction under Anæsthetics

(*a*) *Tongue Slipping Back.*—During extraction under anæsthetics the tongue, not being under control, may slip over the larynx, or may be forcibly pushed back by the fingers of the operator. Symptoms of difficult breathing or even arrest of respiration will follow this accident. Treatment consists in pushing the mandible forward with the thumbs behind the angles or pulling the tongue forcibly forward with a suitable instrument.

(*b*) *Forcing out a Tooth with a Prop or a Mouth-opener.*—This accident may arise from resting a prop upon teeth which are loose, or from placing it in such a position that undue leverage is brought to bear on a tooth. It is an accident most likely to occur when the prop is fixed upon the front teeth and the mouth is opened to its widest extent. Under such conditions undue leverage at right angles to the long axis of the tooth is brought to bear upon the palatal surfaces of the upper teeth, and they are consequently forced outwards.

With a mouth-opener the accident is due to clumsiness; great care should therefore be exercised when using this very powerful instrument. If a tooth is forced out it should, if possible, be immediately replaced.

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[1] ℞ Zinci sulphatis ... ... gr. viii.
Zinci chloridi ... ... gr. vi.
Morphinæ acetatis ... ... gr. ii.
Aquam ... ... ad ℥viii.
M. Fiat lotio.
To be used with an equal quantity of water as a mouth-wash.

[2] *Brit. Med. Journ.*, May 5, 1900, p. 1131.

(*c*) *Passage of a Foreign Body through the Isthmus of the Fauces.*—A foreign body, such as a tooth, a broken piece of forceps, or a prop, passing through the isthmus of the fauces may become impacted in either the air or food passages.

(i) In the air passages it may lodge (*a*) over the entrance of the larynx, (*b*) in the larynx, (*c*) in the trachea or bronchus.

(ii) In the food passages it may lodge (*a*) in the pharynx, (*b*) in the œsophagus, (*c*) at the pyloric opening of the stomach.

(i) *In the Air Passages.*—Should the foreign body lodge *over the entrance of or in the larynx*, the patient will be seized with a violent fit of coughing which may expel it, but if it is not expelled symptoms of asphyxia will supervene. Treatment: the head should immediately be brought forward and the finger inserted along the side of the mouth into the pharynx, and then given a forward sweeping movement; by this means the foreign body, if lodged at the back of the tongue, will probably be removed. If the foreign body is not dislodged by this method, laryngotomy should immediately be performed. This operation must be undertaken and carried out promptly, for any delay diminishes the chance of saving the patient's life.

A foreign body in the trachea or bronchus usually gives rise to a violent fit of coughing with signs of impending asphyxia. These signs pass away and are followed at intervals by fresh attacks of coughing and eventually by symptoms of collapse of the lung or lungs.

When there is a suspicion that a tooth or a piece of a broken instrument may have passed into a bronchus, prompt measures must be taken. In the first place an examination must be made with X-rays, and this, even if negative in character, should be followed by a thorough examination of the chest by auscultation and percussion. In the event of the foreign body being lodged in a bronchus, immediate steps should be taken to remove it, and although in the past this was an extremely difficult undertaking, the introduction of the bronchoscope has rendered the removal of such foreign bodies very much easier.

(ii) *In the Food Passages.*—*A foreign body impacted in the pharynx* will give rise to pain, symptoms of dysphagia and dyspnœa. The patient generally has a hacking cough. Should a foreign body be suspected in the pharynx, its presence can usually be ascertained by digital exploration; this failing, the cavity should be examined by the aid of a laryngoscope.

An attempt should first be made to remove the body with the fingers; and if this is unsuccessful pharyngeal forceps must be called

into use. Where the impaction is very firm, it may be necessary to perform pharyngotomy.

A foreign body in the œsophagus will cause dysphagia, and will probably give rise to constant pain; if it is situated in the upper part it will in all probability give rise to dyspnœa. On applying the stethoscope over the region of the œsophagus, a gurgling sound will be heard when the patient swallows fluids. The presence of a foreign body may be definitely ascertained by the use of the X-rays. If impacted in the upper part of the œsophagus an attempt may be made to remove the impacted body with forceps; this failing, œsophagotomy must be performed. If lodged near the cardiac end of the œsophagus an attempt may be made with a bougie to push the foreign body into the stomach; this failing, gastrotomy should be performed.

If a foreign body becomes impacted at the pyloric opening of the stomach, it will give rise to gastric dilatation. In such circumstances the stomach must be emptied of its contents, and gastrotomy then performed.

(5) Miscellaneous Difficulties, Complications and Sequelæ

(*a*) *Uterine Pain.*—A case is quoted by Sercombe where extraction of a tooth was followed by paroxysmal uterine pain, followed by the cure of an obstinate leucorrhœa.

(*b*) *Menorrhagia.*—A case is recorded, in which a married woman, aged 25, unipara, was seized with violent bleeding from the uterus after the removal of teeth under chloroform anæsthesia. Packing the uterus with tampons saturated with various solutions, and the administration of ergot and strychnine, were tried without success. Finally the uterus was curetted and packed, the hæmorrhage ceasing at the end of twenty-four hours. An examination of the scrapings from the uterus showed the presence of chronic follicular endometritis. Menorrhagia is liable to occur with such local conditions as endometritis, and it is possible that the extraction of the teeth, combined with the chloroform anæsthesia, may have been indirectly responsible for the menorrhagia. The lesson to be learnt from this case is the necessity of avoiding dental operations as far as possible during the menstrual period.

(*c*) *Shock.*—The fact that tooth extraction is a surgical operation and may be followed by shock is often overlooked. As a rule, the shock which follows tooth extraction is negligible, but at times it may be well marked, especially in the weak. The effects of shock are often not sufficiently taken into account when a question arises

as to the number of teeth to be extracted at one sitting. It should clearly be borne in mind that a strong, able-bodied person can bear more severe operations than one of weaker physique.

(*d*) *Syncope at the time of the operation* sometimes occurs. In these circumstances, the operator should immediately desist until recovery ensues. Fainting is best treated by bending the head down towards the knees, at the same time loosening anything tight about the neck and waist and applying ordinary salts of ammonia to the nose. In severe cases the patient should be removed from the chair and laid on the floor, and the chest should be exposed and flipped with a towel dipped in cold water. In more severe cases it may be necessary to inject a cardiac stimulant. Fatal syncope following tooth extraction has occurred. In one case recorded[1] the patient was a female, and an attempt was made to remove a tooth, but owing to alarming syncope the operation was abandoned. A second attempt was about to be made when fatal syncope ensued. *Post-mortem* examination showed nothing beyond a slight amount of cerebral congestion.[2]

(*e*) *Epilepsy.*—In persons predisposed to epilepsy an attack often commences immediately after the extraction of a tooth. If a fit occurs the patient should be removed from the chair and placed on the floor, the clothes at the same time being loosened and a wedge of wood or some suitable material placed between the teeth to prevent injury to the tongue.

(*f*) *Inhibition of the Salivary Glands.*—A case has been recorded by G. L. Curnock[3] of inhibition of the salivary glands following the removal of a difficult mandibular molar. Within twenty-four hours there was great pain, the socket of the tooth was extremely septic, and the flow of the saliva had apparently ceased. The cause appears to have been psychical, as the operation had been dreaded, and a somewhat similar condition had followed on the occasion of an air raid.

(*g*) *Septic and Infective Sequelæ.*—Scattered through dental literature will be found a large number of records of septic and infective diseases which have followed the extraction of teeth. In many of these cases it would be unfair to attribute the infection to the actual operation; in a number of them the actual cause of infection was the neglected condition of the extracted teeth. At times, however, infection can undoubtedly be traced to the opera-

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[1] *Journ. Brit. Dent. Assoc.*, vol. vii, p. 32.

[2] See also case recorded in *Journ. Brit. Dent. Assoc.*, vol. xvii, p. 385.

[3] *Brit. Dent. Journ.*, February 1, 1918, p. 75.

tion, and once again attention is drawn to the urgent necessity of adopting aseptic precautions. Suppuration of the socket and its appropriate treatment has already been dealt upon, p. 746. Cases of syphilis acquired through the use of infected forceps are recorded. The treatment of these conditions hardly lies within the scope of this work.

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CHAPTER XXVIII

Replantation, Transplantation, and Implantation of the Teeth

Replantation is the operation of replacing in its socket a tooth which has been partially or completely dislocated.

Transplantation is the operation of transferring a tooth from its own socket to that of another tooth. The transference may take place in the same mouth, or the tooth may be extracted from the mouth of one person and transferred to that of another.

Implantation is the operation of forming an artificial socket in the bone for the introduction of a natural tooth.

Of these three operations, the only one which is performed to any extent in this country is replantation, the other two being of questionable utility.

(A) REPLANTATION

Replantation should be performed only in cases of traumatic dislocation.

The operation consists in gently rinsing the tooth in a solution of some antiseptic, and replacing it in the socket with firm pressure, the alveolar process being moulded around it with the fingers. The tooth may be kept in place by a metal splint similar to that recommended on p. 185. If the patient is not seen for some hours after the accident, the pulp must be removed, and the canal filled before the tooth is replaced.

The union after replantation is brought about through the periodontal membrane. Where the tooth is living and is immediately replaced, the vitality of the pulp is sometimes re-established. Magitot, who has recorded a large number of cases of replantation, maintains that the operation cannot be successful unless there is a complete ring of healthy membrane on the tooth.

The results of replantation depend upon the nature of the condition for which the operation is undertaken. If the tooth is immediately replaced a successful result may be anticipated; but if replacement is delayed the prognosis is naturally not so good.

(B) TRANSPLANTATION

There are three distinct objections to this operation: (1) The risk of failure; (2) the risk of inoculation; (3) the moral objection. Failure of the operation may be due to (*a*) want of adaptability of the tooth to its new socket; (*b*) morbid conditions of the new socket. The risk of inoculation is a strong argument against this operation —a case of transmitted syphilis has been recorded within recent times. The moral objection to the operation is also weighty, as the teeth to be transplanted are usually obtained from the poorer classes. All circumstances considered, transplantation of a tooth from one patient to another is to be condemned. The transplantation of a tooth from one socket to another in the same mouth is occasionally useful, as, for example, in the transfer of a healthy lateral incisor which has erupted internal to the arch to the socket of an unsavable central incisor. The method recommended for carrying out transplantation is as follows: The patient to receive the transplanted tooth is first operated upon, as little injury as possible being inflicted, and the bleeding from the socket arrested as far as possible. The tooth to be transplanted is next removed from the other patient and immediately transferred to the vacant socket and forced well into place.

Union in transplantation may be a process similar to that which takes place in replantation, or the process may be entirely different and similar to that which occurs in implantation, viz., absorption of portions of the root first taking place. In these excavations, bony tissue is formed continuous with the alveolar process, the tooth thus becoming anchylosed to the jaw. In other cases, it seems possible that there is only a fibrous union.

(C) IMPLANTATION

Implantation is an operation of more recent date than either replantation or transplantation, and is probably less justifiable even than transplantation. W. J. Younger, who was the first to perform this operation, is very particular in the choice of his patients, selecting only young and healthy subjects. The tooth to be implanted should possess a healthy periodontal membrane.

The method of procedure is as follows: A crucial incision is made over the situation intended for the implanted tooth; the flaps of periosteum are then dissected up, and, by means of specially designed trephines and burs, a fresh socket is made. The socket is then syringed so as to remove all débris, and the bleeding is then arrested, the tooth being fixed into place and, if necessary, secured

with ligatures or other suitable means. Some operators force the tooth into place with a hammer; in this way the tooth is firmly fixed and ligatures are not required. Younger does not always use freshly extracted teeth to perform implantation, but in some cases employs dry teeth.

The union taking place after implantation is probably similar to that following many cases of transplantation. A. Amoedo advocates slight decalcification of the roots previous to implanting. The root is placed in a 10 per cent. solution of hydrochloric acid for from three to four hours until the surface of the cementum is slightly softened, the acid being afterwards neutralized with ammonia. The results obtained from implantation are not encouraging, and do not justify the operation.

CHAPTER XXIX

Fractures of the Jaws

This subject may conveniently be considered under two heads:—

(1) Fractures of the jaws (civil life injuries).

(2) Gunshot injuries of the jaws.

(1) Fractures of the Jaws (civil life injuries)

(A) FRACTURES OF THE MANDIBLE.

Fractures of the mandible are more common than fractures of the maxilla, and this is no doubt due to the fact that the mandible is in the more exposed position. The fractures occur more often in the body of the bone than in the ramus; in the body of the bone they are usually compound, in the ramus they are usually simple. The bone is generally fractured in one place only, but multiple fractures are not uncommon.

In a few cases the jaw is fractured in such a way that a portion of a tooth is situated in either fragment.

(i) *Causes.*—Fractures mostly result from kicks, a blow of the fist, or a fall (especially on the chin). Undue violence in the extraction of a tooth may fracture the body of the jaw, but a direct transverse fracture is rarely caused in this way (see p. 743). Fracture of the alveolar process during extraction is a common occurrence, but as it leads to nothing more serious than the exfoliation of the portion fractured, the injury is of little importance. Some rare causes of fracture, as, for example, a fit of coughing, are recorded in "Gross's Surgery," p. 964.

(ii) *Position.*—The position of the fracture depends on the locality in which the blow is received. The most common position of fracture is in the neighbourhood of the canine, and a fracture thus situated is invariably caused by force applied to the chin. When a fracture is caused by a blow on the front of the chin a little to one side of the mid-line it is usually situated in the **region of the canine** on the opposite side; the explanation generally accepted being that the depth of the canine socket weakens the

bone in this region. Another explanation of the frequency of fracture in this region and one which seems more satisfactory is as follows: The resistance to a blow on the side of the chin is met at the articulation of the opposite side; the segment of bone between the regions of impact and the resisting area is a curve; the force of the blow increases the convexity of the curve and the bone gives way at the point of greatest convexity, which is usually between the canine and first premolar. If a blow is received under the middle of the chin the resistance is met at both condyles and the **neck of the condyle** is fractured on one or both sides; in a few cases the neck of the condyle is driven into the condyle causing an impacted fracture. In the case of young children a fall on the chin may lead to a transverse fracture at the **symphysis.** Fracture in the neighbourhood of the **angle** is usually due to direct violence. Fractures of the **ramus** are generally the result of great violence and may occur in almost any position.

(iii) *Symptoms.*—With fractures in the body of the bone the symptoms are generally well marked, but with fractures of the ramus the symptoms are often obscure. In either case the patient usually complains of **pain** on opening the mouth. In the former, there will be distinct crepitus, **mobility in the continuity of the part,** and, frequently, alteration in the line of the teeth, due to **displacement.** The pain in cases of fracture is generally referred to the injured area, but in fractures about the angle the pain is at times referred to the mental foramen. In fractures of the portion of the mandible lying between the inferior dental foramen and the mental foramen, cutaneous anæsthesia is usually present over the area supplied by the mental nerve. There is often more or less salivation and, when the displacement is great, there is sometimes inability to close the mouth.

Skiagrams should be obtained in all cases of suspected fracture, and it is advisable to obtain both antero-posterior and lateral views. The **interpretation of skiagrams** of the jaws is rendered difficult by the shadows on the plate of the skull and the vertebræ, and errors can easily be made. For example:—

(*a*) If the fragments slightly overlap, the line of fracture will be masked in the lateral view; the antero-posterior view will, however, show the line quite clearly.

(*b*) Lateral views of the ramus are often obscured by shadows of the vertebræ and the shadow of the intervertebral discs may simulate a line of fracture.

(*c*) In antero-posterior views of the incisor region the shadow of the intervertebral disc may be mistaken for a horizontal fracture.

(iv) *Displacement.*—The displacement will vary according to the character and position of the fracture, and will be slight in some cases and well-marked in others.

When a fracture occurs in the **incisor region,** the position and direction of the fracture will govern the displacement.

As a rule no displacement occurs with vertical fractures in the region of the central incisors because the depressors and elevators of the mandible counterbalance one another. The "slewing" action of the external pterygoids obviously cannot operate with vertical fractures. But the farther the line of fracture is removed from the median line of the mandible the greater will be the tendency to displacement. The digastrics, with the genio-hyoids, are attached to the inner aspect of the bone on either side of the median line; consequently, the depression of the larger fragments by these muscles tends to increase according as the seat of fracture is removed from the median line.

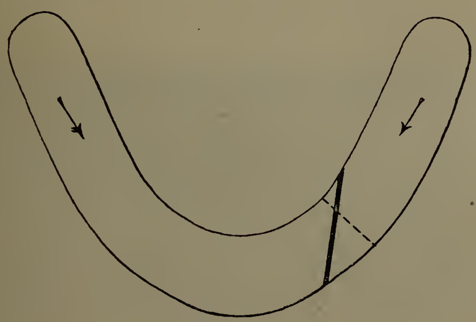

Fig. 843.

The arrows indicate the direction of force exerted by the external pterygoids.

When the fracture runs obliquely through the bone, the action of the external pterygoids will cause the fragments to overlap. Thus, in the left **canine region,** if the fracture runs through the bone from within outwards and forwards, the tendency will be for the left external pterygoid to force the smaller fragment towards the right, and for the right external pterygoid to force the greater fragment to the left, and the combined action will cause the fragments to slide one over the other, the lesser moving in front of the greater. The action of the external pterygoids is diagrammatically shown in fig. 843. The muscles which close the jaw will have a tendency to draw up the lesser fragment because there is no opposition from any of the depressors of the jaw; the depressors are all attached to the greater fragment and depress it, the right

and left depressors combined exerting more force than the counter-acting right elevators.

In double fractures through the canine region, with the lines of fracture taking oblique directions, the following displacement may occur: Attached to the central fragment are the digastrics, the genio-hyoids and the genio-hyo-glossi, and the action of these muscles is to depress the fragment and cause it to fall over towards the tongue; the elevators of the mandible are attached to the lateral fragments and draw them slightly upwards; the left external pterygoid tends to draw the left fragment to the right and the right external pterygoid tends to draw the right fragment to the left, the result being that the lateral fragments move towards the median line and the inward displacement of the central fragment is increased (see fig. 844). In reducing fractures of this kind the foregoing facts should be kept clearly in mind.

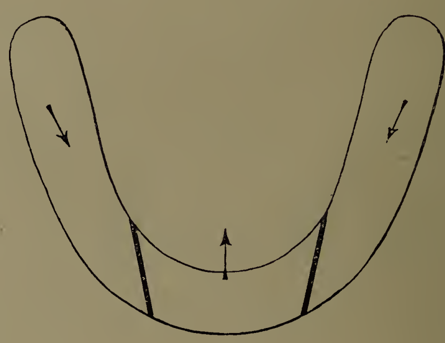

Fig. 844.—(X) Central fragment to which the depressors of the mandible are attached. The arrows indicate the direction of force exerted by the external pterygoids.

With fractures in the **molar region,** the anterior fragment is drawn downwards by the depressors of the mandible. The displacement of the posterior fragment is governed by the resistance to the upward pull of the elevators of the mandible. This resistance depends upon (*a*) the presence or absence of teeth and (*b*) the direction of the line of fracture. If teeth are present in the posterior fragment as well as in the maxilla, the upward pull is resisted irrespective of the direction of the line of fracture. If the fragment is without teeth or possesses only teeth which are unopposed by maxillary teeth, a displacement upwards and forwards will occur, provided that the line of fracture does not resist the movement. To make this statement clear, attention is drawn to

the diagram (fig. 845). If the break takes the form (*a*), (*b*), or (*c*), the upward and forward pull is resisted by the anterior fragment, but when the break is as shown in (*d*), there is no resistance to the upward and forward movement and considerable displacement follows (see fig. 846).

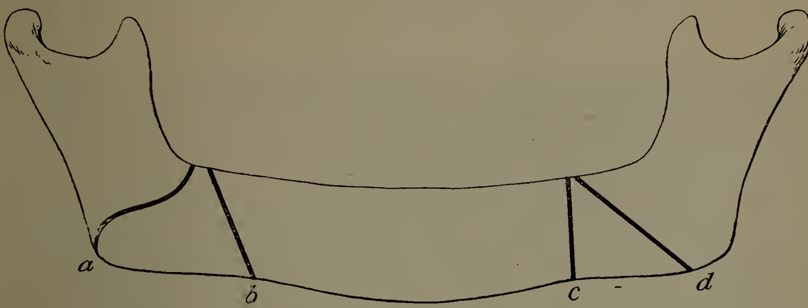

FIG. 845.

FIG. 846.—Fracture through the region of the second molar, showing marked upward displacement of the posterior fragment.

An instructive case is shown in figs. 847 to 849. The jaw was struck in the locality of the left molar teeth. The bone was fractured on the left side about the region of the third molar and on the right side in the position of the premolars. In both fractures

the break of continuity took the form of a curve, as shown in the diagram (fig. 847). Both the posterior fragments, which were

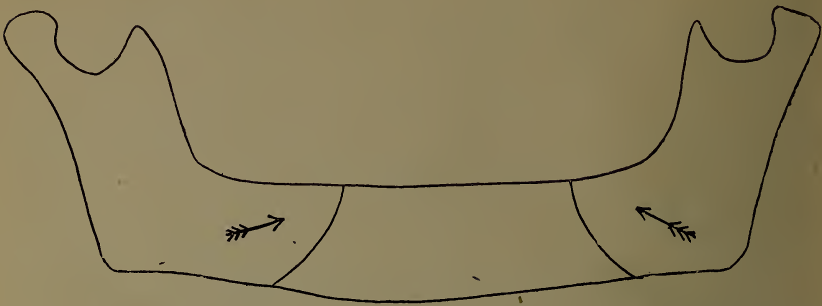

FIG. 847.[1]—The arrows indicate the direction of force exerted by the muscles attached to the posterior fragment.

FIG. 848.[1]

[1] From *British Dental Journal.*

without teeth, swung forwards and slightly upwards, following the direction of the curves, the combined forward movement pushing the central fragment well forwards so that the patient presented a condition of inferior protrusion. The skiagrams of this case are shown in figs. 848 and 849.

Fractures in the molar region are often due to **direct** violence, the force of the blow driving one of the fragments inwards. In

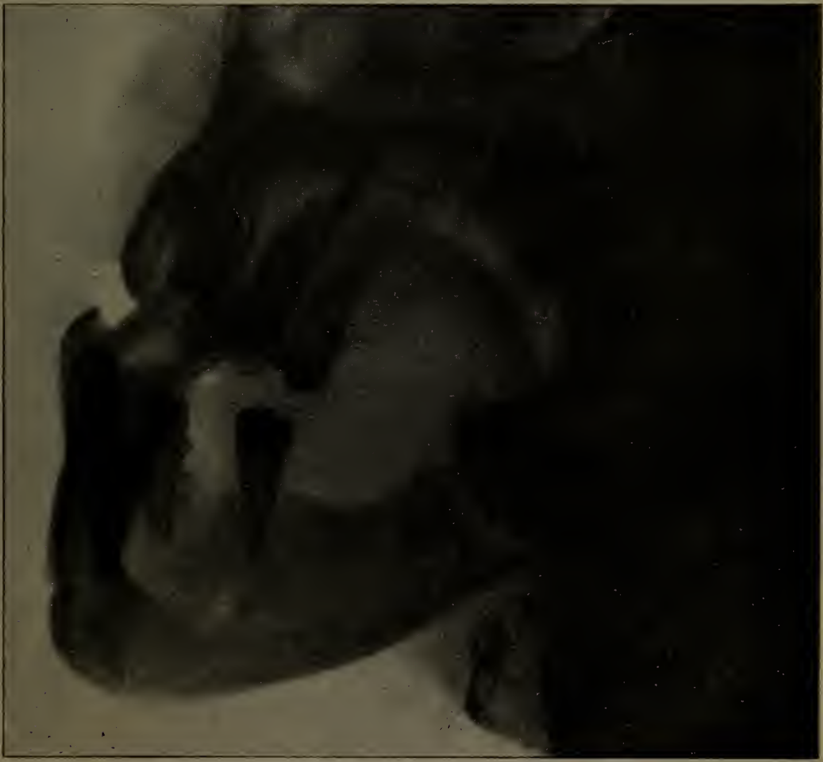

Fig. 849.[1]

such cases the forward movement of the posterior fragment and the deviation of the anterior fragment to the injured side result in an overlap of the fragments, which is at times extremely difficult to control in consequence of the action of the superior constrictor of the pharynx. This muscle has an attachment to the mandible immediately above the posterior extremity of the mylo-hyoid ridge, and each act of swallowing exerts an upward and inward drag on

[1] From *British Dental Journal.*

the posterior fragment. When the posterior fragment lies internal to the anterior, the "drag" can be observed if the patient is made to close the mouth and swallow. When the posterior fragment lies external to the anterior, the inward and upward movement is prevented by contact with the anterior fragment, in other words, the movement of the fragment is controlled.

Fractures of the ramus are generally accompanied by much swelling, but usually the displacement is slight. With transverse fractures, the upper fragment, to which the temporal muscle is attached, moves a little forward, while the lower fragment moves a little backwards and inwards.

In *fractures of the neck of the condyle* the mandible is drawn upwards on the injured side and also over to that side, the condyle being drawn forward on the eminentia articularis by the external pterygoid muscle. The distal molar teeth on the injured side are in contact, the remaining teeth being separated. This mal-occlusion

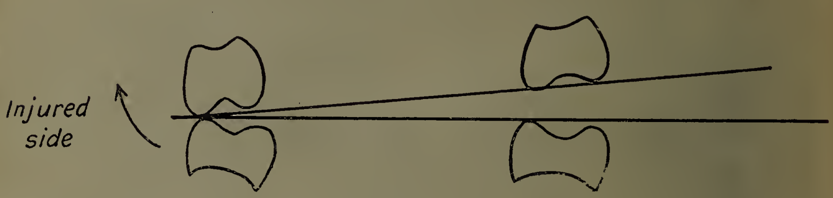

FIG. 850.[1]

is brought about as follows: The upward pull of the muscles on the injured side brings the external aspect of the outer cusps of the lower teeth hard against the inner aspect of the outer cusps of the upper teeth; a continuation of the upward movement tends to rotate the jaw around these points of contact, as shown in the diagram (fig. 850).

When both condyles are fractured, the mouth is "gagged" open on the posterior teeth, producing a condition of "open bite."

When the *coronoid process* is fractured, there is no displacement with the teeth in occlusion, but, on opening the mouth, the mandible may deviate away from the injured side owing to the unopposed action of the temporal muscle on the uninjured side.

A severe blow on the chin may fracture the mandible in the incisor region on the one side and through the ramus on the other side. A typical instance is shown in figs. 851 and 852. On the

[1] From *British Dental Journal.*

left side the bone was fractured in the position of the canine in an oblique direction, and on the right side the ramus was split in a vertical direction. The displacement in this type of injury is as follows: The left fragment passes to the right; the central

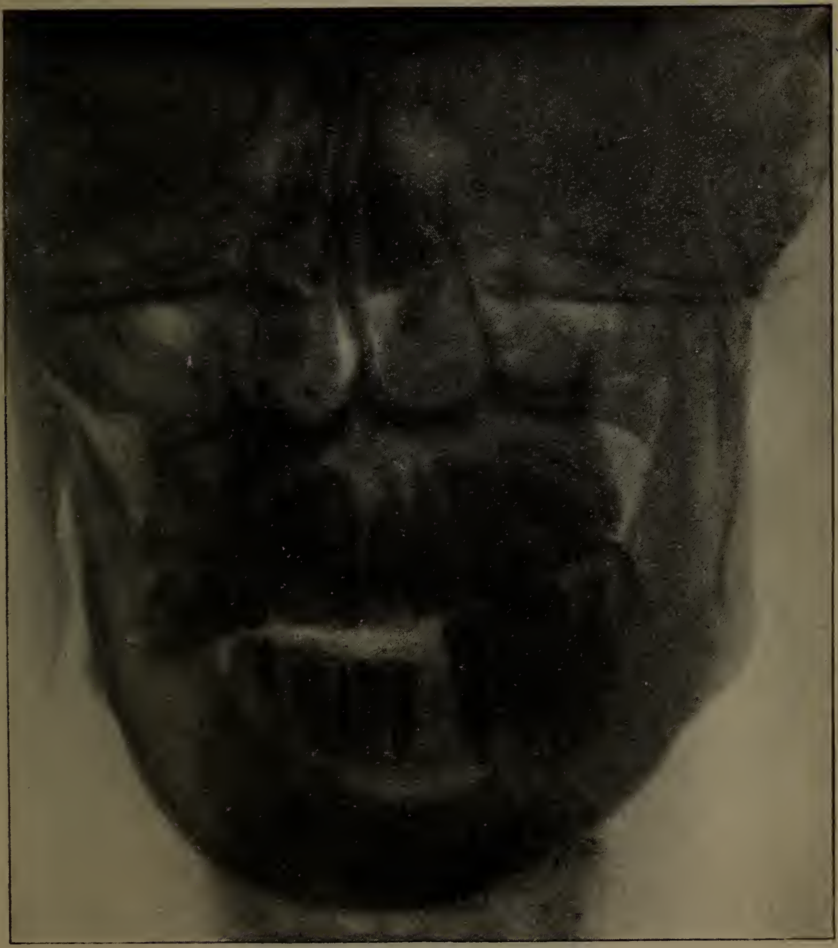

Fig. 851.[1]

fragment is rotated so that the anterior end is displaced downwards and the posterior end upwards. The depressors of the jaw being attached to the anterior end of the fragment, and the elevators being attached to the posterior end the pull of each set of muscles

[1] From *British Dental Journal.*

is in opposed directions, and the fragment is rotated at the area of contact between the last molars.

With severe injuries, such as those caused by a kick from a horse, the jaw is often fractured in several directions, the force

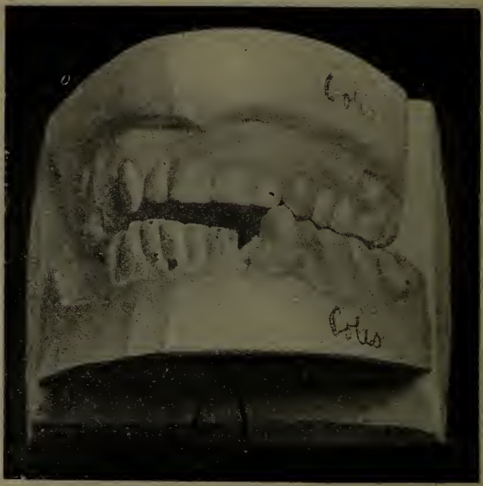

Fig. 852.[1]

and direction of the blow being a potent factor in determining the degree of displacement. As an example the case shown in figs. 853 and 854 may be quoted. The injury was due to a mule kick in the region of the first molar on the left side.

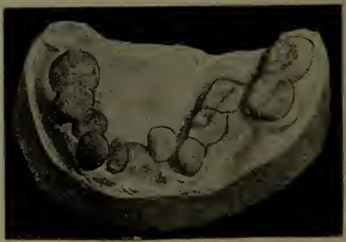

Fig. 853.[1]

The bone injuries were: (1) A fracture near the mid-line running downwards and backwards to the lower border of the bone; (2) a vertical fracture between the first and second molars; (3) a

[1] From *British Dental Journal.*

horizontal fracture connecting the two vertical fractures (see fig. 855). There was practically no comminution of the bone. In this case the left lateral fragment had swung forwards and upwards, and, owing to the backward displacement of the central fragment the first molar was lying on the inner side of the second molar.

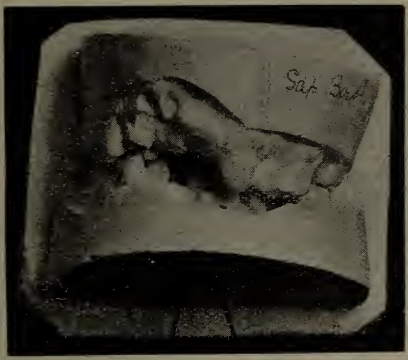

FIG. 854.[1]

The right lateral fragment had swung over to the left and was slightly depressed.

(v) *Complications.*—The principal immediate complications in fractures of the mandible are extensive bruising of the soft tissues with, in a few cases, considerable laceration. Hæmorrhage is in

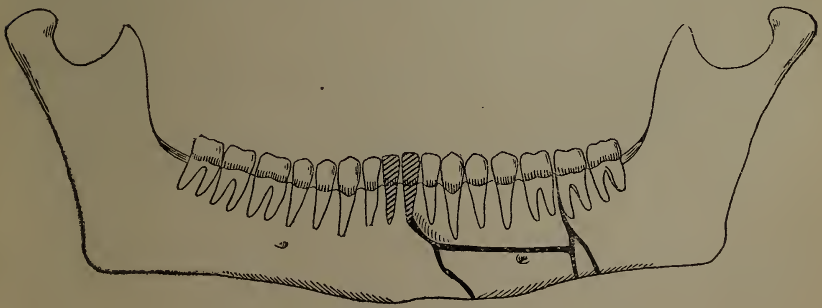

FIG. 855.[1]

some cases troublesome and seems to occur most frequently in fractures about the angle. It is probably due to the artery being torn and not completely divided. In rare instances a traumatic aneurism forms, and necessitates the ligature of the external carotid.

[1] From *British Dental Journal.*

The fracture may be associated with a dislocation of the temporo-mandibular articulation and occasionally with a fracture of the base of the skull.

(vi) *The Healing of Fractures of the Mandible.*—Repair of the fractured mandible takes place in a manner similar to repair of long bones. Briefly, the stages are as follows:—

(1) The fractured ends are surrounded with a coagulated mass of leucocytes, blood and exudation from the vessels in the neighbourhood.

(2) The coagulum is invaded by cells—polynuclear from the surrounding soft tissues, fibroblastic from the periosteum and medulla.

(3) The coagulum is in time replaced by tissue derived from the periosteum and medulla. This tissue is

(4) Converted into cartilage (in cases where the callus is small this stage may be lacking).

(5) The cartilaginous tissue is converted into osteoid callus, i.e., the cartilage cells are modified into bone corpuscles with a deposit of calcareous salts in the matrix leading to the formation of imperfect bone.

(6) The imperfect bone is in time replaced by lamellar bone. This last stage is seen in fig. 880.

In *simple fractures osseous union is usually complete in six weeks*, but in cases where the treatment has been delayed, or there has been difficulty in reducing the fragments, union may not be complete in less than eight or ten weeks. In cases of doubt a skiagram should be obtained.

(vii) *Treatment.*—The treatment of fractures of the mandible consists in (1) control of the sepsis; (2) reduction of the displacements; (3) immobilization of the fragments.

As soon as the patient comes under treatment the mouth should be frequently irrigated with peroxide of hydrogen (2 vols.), and the gums swabbed once a day with a 2 per cent. solution of iodine in alcohol, and the fracture rested with a *skull and mandibular splint* (fig. 856).

The apparatus consists of a skull cap woven out of thick mercerised cotton and bordered by a rim of braid about three-quarters of an inch wide. Hooks are fitted on each side, two being placed in front and one behind. The mandibular splint is made of metal, the ends of the splint being turned over to form catches. The skull and mandibular sections are united by cord or tape and, according to the pressure exerted, either an upward or a backward pull can be obtained.

If a skull and mandible splint is unobtainable, a temporary rest splint of gutta-percha can be substituted. A piece of gutta-percha is cut similar in shape to that shown in fig. 857, and is softened in

Fig. 856.[1]

hot water; the part (*a*) is placed under the chin, the two ends (*a*1) being bent upwards over the rami; the portion (*b*) is then bent round as shown in fig. 858. Several holes should be made to allow of

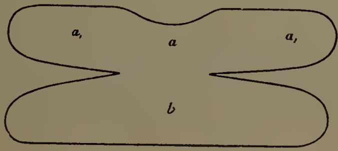

Fig. 857.

evaporation; the splint should be lined with cotton-wool and held in position with a four-tailed bandage.

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[1] From *British Dental Journal*.

Skiagrams should be obtained, and as soon as his condition permits the patient should be given an anæsthetic. If the extractions are likely to be difficult, anæsthesia should be induced by the administration of chloroform and ether, followed by pure chloroform. Before the operation is commenced the tongue should be brought under control by suitable means, and, during the operation, care should be taken to control the hæmorrhage.

Teeth bordering on the line of fracture or communicating with the fracture should be removed as well as any septic teeth which may be present. The removal of the teeth in the region of the fracture is considered by some practitioners to be an unnecessary step, but in my opinion it is essential treatment. When the line of fracture passes through the socket of a tooth the periosteum of the root is detached and a pocket is formed which becomes filled with septic matter. The periosteum covering that part of the root is destroyed, and a permanent "pocket" is formed from which infection is constantly passing to the fractured area. The removal

Fig. 858.

of the tooth or teeth eradicates this focus of infection and rapid healing follows. A perusal of the records of the cases quoted in the following pages will convey an idea of the results obtained by free extraction of the teeth in the region of fracture. But the best evidence in favour of this method of treatment is to be found in a study of cases of delayed union. The skiagrams of many of these cases show the roots of teeth in the line of fracture, and the removal of the teeth is invariably followed by rapid healing of the fracture.

The *immobilization of the fragments* is usually carried out by means of interdental splints or wiring.

(1) *The Interdental Wire Splint.*—This splint, which bears the name of Hammond, is made of wire encircling the lingual and labial sides of the teeth, the individual teeth being wired to the splint (fig. 859). The splint is difficult to adjust, and the wire ligatures hurt the gum margin. It cannot easily be kept clean and cannot be relied upon to immobilize the fracture.

(2) *The Metal Cap Splint.*—This splint consists of a metal cap fitted accurately to the teeth and is fixed into position by means

of oxyphosphate of copper cement. A double cap-splint embracing both upper and lower teeth is the most reliable of all the types of splints (see figs. 860 and 861).

At the Croydon War Hospital, where considerable experience has been gained in the construction of this type of splint, the procedure is as follows:—

(*a*) Accurate impressions of the teeth are obtained in "Stent" composition.

Fig. 859.

Fig. 860.

(*b*) The caps are made of Victoria metal and are cast. In casting the metal a plentiful supply of flux is employed and care is taken not to overheat the metal.

(*c*) The splint is made in sections; for example, in a case where the teeth have been removed from the line of fracture, separate caps are made for the teeth in the two fragments.

(*d*) The model of the splint is made in wax (No. 8 thickness), the wax being carefully pressed between the teeth and extended as far as the gum margin.

(*e*) The caps are adjusted to the teeth, care being taken to see that the occlusion is correct. The fracture is reduced, and the position of the caps fixed with composition.

(*f*) The sections of the splints are soldered together with silver solder, connecting bands of wire being used if necessary.

(*g*) The splint is finally adjusted in the mouth, the fracture reduced, and the splint fixed with oxy-phosphate of copper cement.

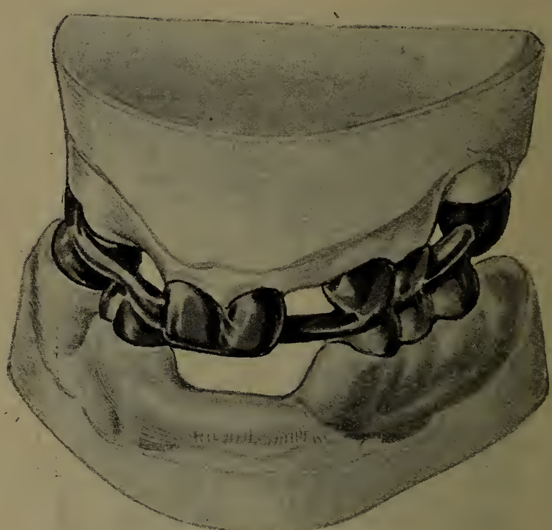

Fig. 861.

In cases where the displacement is marked, reduction must be carried out by easy stages (see p. 775).

(3) *The Gunning splint* (fig. 862) consists of vulcanite caps joined by supports, and constructed to fit both the maxillary and the mandibular teeth or gums. When the splint is in position a skull and mandibular splint or a four-tailed bandage is applied. With this type of splint the fractured jaw is fixed between the mandibular splint outside and the cranium. The Gunning splint is useful in cases where the patient is edentulous or possesses few teeth.

In many cases a combination of metal caps and vulcanite is found very useful. There are many other types of splint, but the experience gained from the treatment of war injuries has shown

that the best results are obtained with either the metal cap splint or the Gunning splint.

The Gradual Reduction of Displacements.—The gradual reduction of a fracture may be carried out in a variety of ways, different

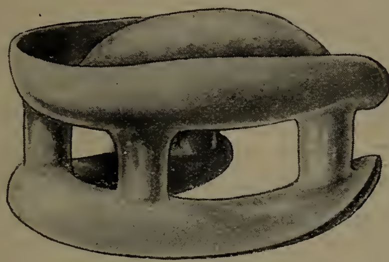

Fig. 862.

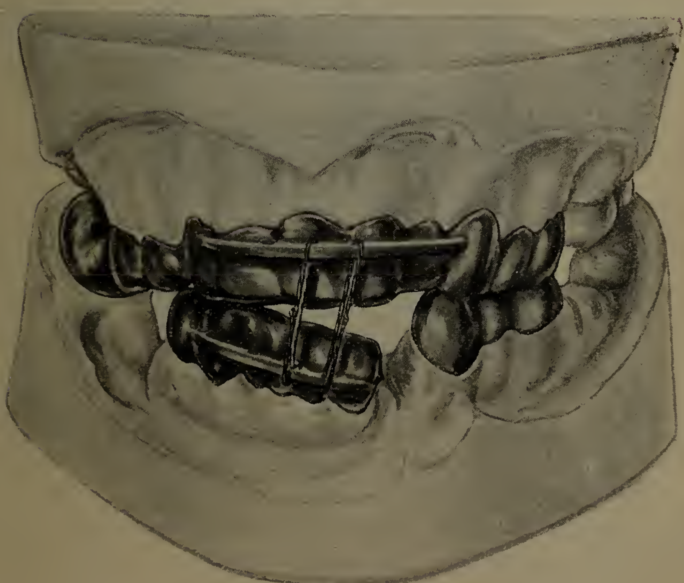

Fig. 863.

operators preferring different methods. The method adopted in the following cases gives excellent results:—

In the case shown in fig. 851 a double metal cap splint was fixed to the maxillary teeth and the teeth on the left side of the mandible, a single cap splint being fixed to the teeth on the right side of the mandible with studs soldered to the mesial end. On

the double cap splint studs were fixed immediately above the position of the studs on the lower splint. Upward traction was exerted on the displaced fragment and a ligature of wire bound round the studs (fig. 863). Additional traction was exerted each day until the displacement was overcome. In this case the fragment was rotated into position, the rotation taking place at the contact between the last molar teeth.

In a few cases it is advisable to reduce the fracture before removing the teeth. This method was adopted in the case shown in figs. 853 and 854.

The model of the mouth was obtained with extreme difficulty. The teeth present were:—

$$\begin{array}{r|l} 876\ 43\overset{*}{2}\overset{*}{1} & \overset{*}{1}\ 34\ 6\overset{*}{7}8 \\ \hline 8765432 & \ \ 2345678 \end{array}$$

The case was treated as follows: A splint was constructed which firmly capped the premolars and molars on the right side and the

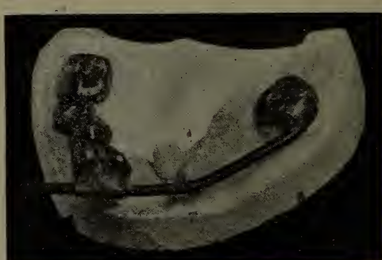

Fig. 864.[1]

second and third molars on the left side; the two caps were joined with a screw extension (fig. 864), the force being exerted to push the left fragment outwards and allow the central fragment to move forwards. The apparatus was adjusted, and six days later the displacement had been reduced so that the second molar only just overlapped the first molar. The following teeth were then removed,

$$\begin{array}{r|l} 7\quad \overset{*}{2}\overset{*}{1} & \overset{*}{1}\qquad\quad 8 \\ 2 & \ 2\quad 67 \end{array}$$

and three days later a metal Gunning splint was fixed in position.

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[1] From *British Dental Journal.*

At the end of three months there was firm osseous union with the teeth in good position (fig. 865).

In this case complete reduction was not carried out because it was clear from the skiagram that the first and second molars were in the line of fracture and would have to be removed.

In treatment there is always a difficulty in controlling the posterior fragment, and in the above described case the only available fixed point was the third molar, whose stability is not always to be relied upon owing to the shape of its roots. It has also been observed that, if the posterior fragment overlaps the anterior fragment, union generally follows, the anterior fragment acting as a resistance against the inward pull of the superior constrictor and mylo-hyoid on the posterior fragment.

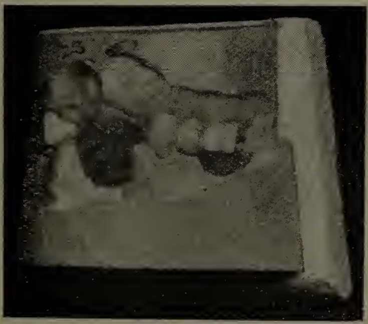

Fig. 865.[1]

Wiring of the Fragments.—In a few cases where the fragments cannot be controlled by means of interdental splints, immediate wiring of the fragments may be adopted.

Simple fractures of the mandible if properly treated should repair within three months, and if at the end of that period union has not occurred the case must be regarded as one of "delayed union." When there is delayed union there are three possible issues, namely:—

(1) Osseous union.

(2) Union by a band of dense fibrous tissue, the fracture having a slight "give."

(3) Non-union, the fragments being freely movable.

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[1] From *British Dental Journal.*

The commonest cause of delayed union is the presence of septic teeth in the line of fracture. An example is shown in fig. 866. The skiagram was taken three months after injury. The removal of the affected teeth was followed by rapid union.

Occasionally the infection from the teeth leads to extensive rarefaction of the bone, or, if the infection is mild in type, to a

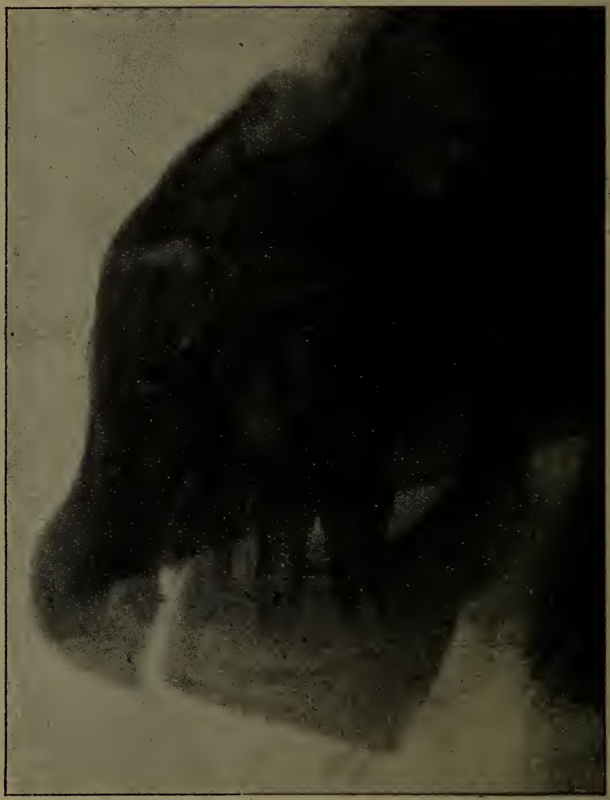

Fig. 866.[1]—Skiagram of a case of "delayed union" showing the root of a tooth in the line of fracture.

sclerosis of the margin of the fragments. Both of these conditions result in non-union.

Another cause of delayed union is the presence of a thin layer of necrosed bone between the fragments. Skiagrams of recent fractures sometimes show a thin detached portion of bone between the fragments. This thin layer of bone may become infected and necrosed and so lead to non-union.

[1] From *British Dental Journal.*

Imperfect reduction of fractures with considerable overlapping of the fragments leads to prolonged delay, and so also does non-immobilization of the fragments. The latter condition cannot always be prevented where teeth are absent. In fractures posterior to the last molar tooth the constant movement of the fragment by the superior constrictor of the pharynx is a common cause of delayed or even non-union.

Even where the fragments have been immobilized and danger from sepsis has been quickly eliminated union is at times delayed. This is possibly due to defective power of repair on the part of the individual. It has been suggested that in such cases there is defective calcium metabolism, and the administration of thyroid extract has been advised, but this drug has been tried at the Croydon War Hospital without any trace of improvement.

With diabetics or where there is a history of syphilis union is at times delayed.

In cases of non-union, sepsis, if present, should be removed, and when the tissues have thoroughly recovered, the ends of the bone should be freshened sufficiently to expose the medulla and the fragments approximated and immobilized either by means of interdental splints or by a wire suture through the bone.

Mal-union.—Where the occlusion is only slightly deranged, the simple operation of "cutting in the bite" will often suffice to correct the mal-occlusion. In fractures about the last molar tooth and in fractures of the ramus the mouth may remain gagged on the posterior teeth which will need to be removed in order to bring the remaining teeth into occlusion. Failure to reduce the fragments correctly may result in marked deformity. For example, in fractures behind the last standing tooth, the posterior fragment may swing forward and the covering muco-periosteum come into contact with the upper teeth. Discomfort and perhaps ulceration of the soft tissues follows. The patient, in order to avoid the discomfort, involuntarily brings the jaw over to the injured side and the face becomes markedly deformed. In other words, the patient acquires a "bite of comfort" at the expense of his personal appearance. A similar condition is seen in fractures of the molar region where the anterior fragment has moved to the injured side and union has followed. An attempt to bring the mandible over to the uninjured side is resisted because the soft tissues covering the ramus would then come into contact with the upper teeth.

The treatment consists in the removal of one or more of the maxillary molars on the injured side, the patient being encouraged to use the teeth on the uninjured side. In some cases the upward

movement of an edentulous posterior fragment is so extreme that the fragment lies external to the alveolar process of the maxilla. In such cases extraction of the teeth is not always sufficient to bring about union, and it is necessary to cut away the bone freely including the tuberosity. If the mal-union is of long standing, it may be necessary to train the mandible into position, either by means of an engaging flange, or by means of stretching splints. An engaging flange is an apparatus adjusted to the teeth in such a manner as to cause the teeth to occlude in a normal position.

The stretching splint is made as follows:—

(1) Metal caps are adjusted to the maxillary and the mandibular teeth.

(2) The maxillary splint is covered with a layer of soft composition. A grip of the mandibular teeth on the injured side is obtained and as the mouth closes the mandible is firmly brought over to the uninjured side.

(3) The splints are soldered together; the upper cap is placed in position and the mandible guided into the lower splint.

(4) The mandible is retained in this position until the patient can easily bring the teeth in and out of the splint.

(5) The splints are unsoldered and the mandible is brought over still further to the uninjured side, the operation being repeated until the correct position is obtained.

(B) FRACTURES OF THE MAXILLA

Fractures of the maxilla are generally caused by great violence. Frequently the bone is comminuted, and adjacent bones, such as the malar and nasal, are implicated. When the impacting force strikes the bridge of the nose in a downward direction, a transverse fracture of both maxillæ may result, the line of fracture passing high up and involving the infra-orbital plate. In such cases the whole maxilla can be moved "en masse," and there is extreme ecchymosis of the soft tissues. This type of fracture not infrequently results from certain aeroplane accidents. When the machine strikes the ground, the pilot's head is jerked forward and his face comes into contact with the lower part of the frame of the observing screen. If the impact is received on the lower part of the maxilla, multiple fracture of the lower portion of the bone results.

Separation of the two halves of the maxilla in the median line has been recorded. Lastly, *fracture of portions of the alveolar process and of the tuberosity* occasionally occur during the extraction of teeth.

The *complications* encountered are very similar to those met with in fractures of the mandible, but hæmorrhage is generally more severe. At times the infra-orbital nerve is permanently injured.

Method of Union.—Repair in the fractured maxilla appears to be invariably of a fibrous and not osseous character. I have examined many cases and have been unable to satisfy myself that osseous union has actually occurred in any of them.

Treatment.—In transverse fractures above the level of the roots of the teeth, the maxilla should be rested by means of a double metal cap splint, which should be retained in position with the aid of a skull and mandibular apparatus.

Another method is to cover the maxillary teeth with a metal cap, attaching to the sides of the cap stout wires bent so as to clear the angles of the mouth and to lie along the outer side of the cheeks. The wires are then attached to a skull splint.

In multiple fractures through the alveolar portion of the bone, the teeth involved should be removed and a Gunning splint used until repair has taken place.

The removal of the teeth must be carried out with extreme care. It is often a useful plan to grasp the tooth next to the one to be removed with a pair of forceps and exert pressure in an upward direction during the extraction. If this precaution is not taken undue laceration of the parts may occur. At times the teeth are more easily removed by exerting force in a lateral direction with a straight elevator, and if the muco-periosteum is unduly adherent it should be pared off with suitable instruments.

When there is considerable comminution of the teeth the muco-periosteum should be raised from the outer aspect of the bone and a view obtained of the alveolar process; the broken fragments can then be easily removed together with loose pieces or sharp edges of bone, the muco-periosteum being brought together with sutures.

In the maxilla the line of fracture may run immediately above the roots of the molars, the whole segment of bone being detached. Union under these conditions does not occur, and it is better to remove the whole segment. The muco-periosteum is first reflected from both sides of the bone and the detached portion carefully dissected out, the edges of the soft tissues being brought together with sutures.

The rapidity of the recovery of patients with severe multiple fracture of the maxilla, when the teeth are removed, is remarkable. Moreover, the teeth if retained are of no value for mastication, the bone around them is liable to necrose, and the maxillary sinus to become infected.

(2) Gunshot Injuries of the Jaws

In times of peace, gunshot injuries of the jaws are of rare occurrence and are mostly met with in men under military training. As these injuries will in the future come more and more under the care of the dental surgeon it is necessary that he should possess some knowledge of their nature and the best methods of treatment.

In gunshot injuries of the jaws there is frequently considerable loss of tissue and much comminution of the bone, and in these respects they differ from the jaw injuries ordinarily met with in

Fig. 867.[1]

civilian practice. The damage to the bone would seem in some measure to be governed by:—

(1) *The Type of Missile.*—A bullet tends to comminute the bone into smaller fragments than "shrapnel."

(2) *The Velocity of the Missile.*—The higher the velocity the greater, as a rule, the degree of comminution.

(3) *The Angle of Impact.*—A bullet which strikes the bone at a right angle cuts away the bone in its course, but does not necessarily cause extensive comminution of the remaining fragments. An example is shown in fig. 867. The bullet struck the bone at a right

[1] From *British Dental Journal.*

angle near the lower border and carried away the portion below the tooth. The tooth remained in position, being firmly wedged in place by the approximation of the fragments. If a bullet strikes the bone at an oblique angle widespread comminution is caused, but there is little loss of tissue. An example is shown in figs. 868 and 869. The bullet entered the lower lip one inch to the right side of the mid-line and came out on the left side near the level of the hyoid bone at a point midway between the angle of the jaw and the

Fig. 868.[1]

symphysis. The mandible was therefore hit at a very oblique angle, and the bullet took a slightly downward course. The bone was fractured in a vertical direction between the right central and lateral incisors, the comminution extending beneath the $\overline{54321|123}$.

The photograph of the patient shown in fig. 870 depicts the entrance and exit wounds, the former being on the cheek. It would seem from the direction taken by the bullet that the lower border

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[1] From *British Dental Journal.*

of the mandible was little more than grazed, yet the concussion was sufficient to comminute the bone in the manner shown in fig. 871.

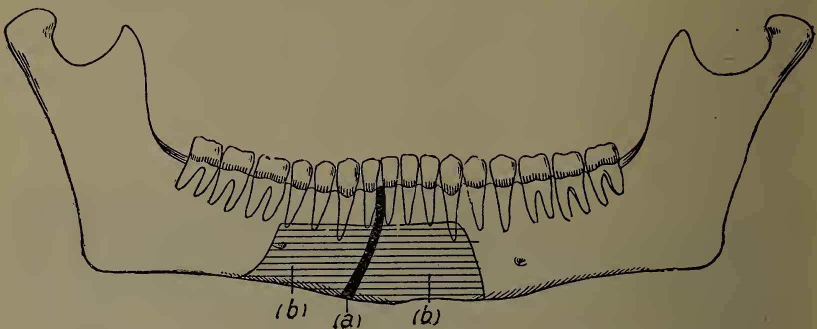

FIG. 869.[1]—(*a*) line of vertical fracture: (*b*) area of comminution.

FIG. 870.[1]

(4) *The Character of the Bone receiving the Impact.*—The harder the bone the greater the degree of comminution. A missile which strikes the hard compact tissue of the lower part of the body

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[1] From *British Dental Journal.*

of the bone will cause more comminution than one which strikes the alveolar process.

Treatment

(1) *General Lines of Treatment.*—The healing of gunshot injuries is in a great measure dependent upon the presence and extent of a septic condition in the region of the fracture, and the rate of healing will be largely measured by the duration of the sepsis. The general lines of treatment to be adopted are briefly as

Fig. 871.[1]

follows: With much laceration and suppuration of the soft parts, the first object should be to clean the parts and remove the sepsis. For this purpose chloramine and eusol are very efficacious, and the rapidity with which wounds will clear up when treated with these preparations is very remarkable. The mouth is frequently irrigated with peroxide of hydrogen (2 vols.), and the gums swabbed once a day with a 2 per cent. solution of iodine in alcohol. Skiagrams of

[1] From *British Dental Journal.*

the injured area are next obtained, and here it should be mentioned again that both lateral and antero-posterior views are necessary. The next stage is to examine the patient under an anæsthetic. In cases of recent injury the examination has often to be delayed until the patient has sufficiently recovered from the shock of the injury to undergo anæsthetization with safety. The anæsthetic should be administered with extreme care on account of the swollen condition of the soft parts, and the slightest interference with the passage of air to the lungs must be avoided. Before the operation is commenced the tongue should be brought under control; this is especially necessary if the tongue is partially bound down by adhesions or if a central fragment exists. The parts are next examined in order to ascertain how far reduction is possible. Teeth bordering on the line of fracture, or communicating with the fracture, are then removed, as well as any septic teeth which may be present. While the teeth are being removed, every precaution is taken to prevent blood passing into the pharynx. The extractions should be carried out very cautiously and with as little violence as possible, the teeth being, so to speak, gradually enticed from their sockets. Sharp edges of bone left after the removal of the teeth should be trimmed away and the edges of the muco-periosteum brought into apposition by sutures. The lacerated tissues of the cheek and lips should, if their condition permits, be brought together.

(2) *The Approximation of the Fragments.*—To obtain osseous union it is essential that the fractured ends of the mandible should be brought into contact, or that living bone should exist in the tissues between the fragments of bone. The approximation of the fragments will result in a narrowing of the arch and some loss of masticating area, but the masticating area can be restored by properly constructed artificial dentures. Some writers who place considerable stress on correct occlusion of the teeth maintain that, if the fractured ends are kept apart, fresh bone will eventually bridge the gap. There is nothing in pathological teaching or experience to support this view, and if bone cells do not exist in the tissues uniting the fragments it is difficult to see how fresh bone is to be created. The cases in which bone has been observed to form have probably been examples of comminution of the tissues with the fragments of bone remaining and forming nuclei for bone growth. Experience shows that many of these cases end, as might be expected, in fibrous union. The choice would therefore seem to lie between a mandible firmly united and capable of bearing the strain of an efficient denture, or the teeth in correct occlusion on a base not capable of bearing the strain of mastication.

In the incisor region the fragments are allowed to approximate, provided that the narrowing does not lead to marked deformity of the face and disorganization of the occlusion. An example may be quoted:—

The bullet carried away the bone, as shown in fig. 872. The

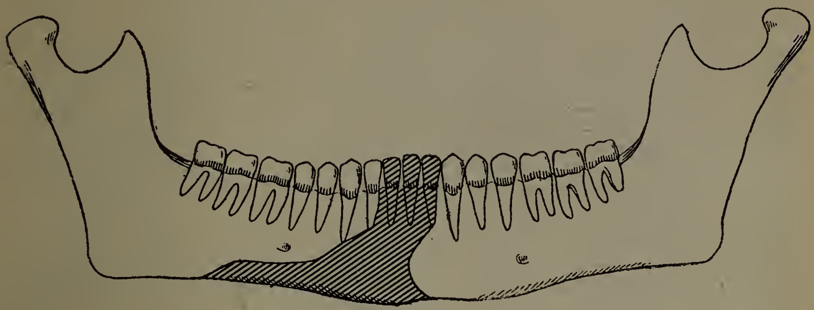

FIG. 872.[1]

parts were approximated, osseous union followed, and occlusion of the teeth was very slightly impaired (fig. 873).

In the molar region the following method is adopted: The upper teeth opposing the teeth of the posterior fragment are removed,

FIG. 873.[1]

allowing the posterior fragment to move forwards and upwards, and the anterior fragment to swing over to the injured side. The following method is pursued:—

Where the gap is small, the posterior fragment is released, and a splint made with the anterior fragment in position. Skiagrams are then obtained. If the bony parts are found to be in contact,

[1] From *British Dental Journal.*

the splint is fixed in position; otherwise the anterior fragment is brought across until contact is obtained. The mandible may thus be mended with the anterior fragment swung over to the injured side, but this is no disadvantage because, with the removal of the splint, there is a tendency for the mandible to adjust itself to functional activity, provided that the so-called "bite of comfort" is avoided (see p. 779).

It is difficult to indicate to what extent the fragments may be allowed to approximate without causing undue deformity, and it is probable that the degree of approximation which is safely attainable differs in individual cases. Good results may be confidently anticipated if the gap is less than half an inch, and, even with gaps up to three-quarters of an inch, approximation may prove successful in some cases. With a wider gap, approximation of the fragments must give way to bone grafts for the formation of an osseous bridge.

(3) *Fixation of the Fragments.*—Splints similar to those described on p. 773 should be used to fix the fragments. The splints should be adapted as soon as the condition of the tissues permits, but they should not be fixed until the sepsis is completely under control.

(4) *Cases illustrating Methods of Treatment.*—An idea of the methods to be adopted and the results to be anticipated can perhaps be best conveyed by an account of typical cases:—

(*a*) *Comminuted Fracture of Incisor Region.*—A fracture was caused by a machine-gun bullet which struck the bone on the lower border in the region of the left premolars and passed in a slightly upward direction emerging on the right side about three-quarters of an inch below and external to the angle of the mouth. On admission three weeks after the injury the teeth present were:—

$$\begin{array}{r|l} 8765432\overset{*}{1} & 12345\overset{*}{6}\overset{*}{7}8 \\ \hline 8765\qquad\quad & \qquad\ 5678 \end{array}$$

There was considerable induration of the soft tissues; a sinus was present under the chin; the pulse-rate was 102, and the temperature 100·4° F. The bullet had carried away the eight anterior teeth.

The skiagrams of the patient are shown in figs. 874 and 875 and a diagram of the fracture in fig. 876.

The following teeth were removed:—

$$\begin{array}{r|l} 8\quad\ \ \ \overset{*}{2} & \quad\ 4\ 6\ 8 \\ \hline 8765\qquad & \quad\ 5\qquad \end{array}$$

The suppuration in the mouth rapidly disappeared, the fragments in the meantime being allowed to approximate. A splint

FIG. 874.[1]

FIG. 875.[1]

[1] From *British Dental Journal.*

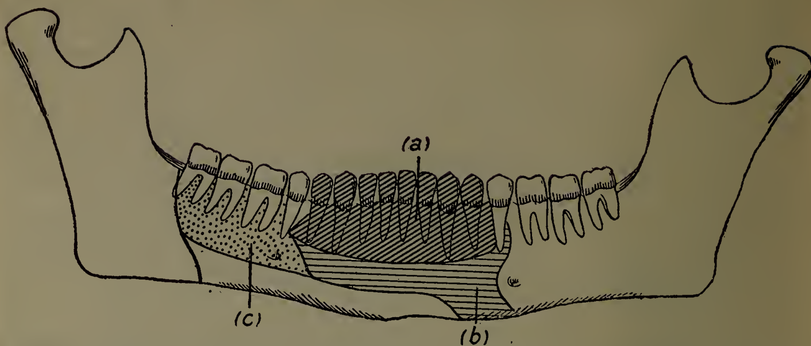

FIG. 871.[1]—(a), tissue lost by injury; (b), area of comminution; (c), area showing marked rarefaction of the bone.

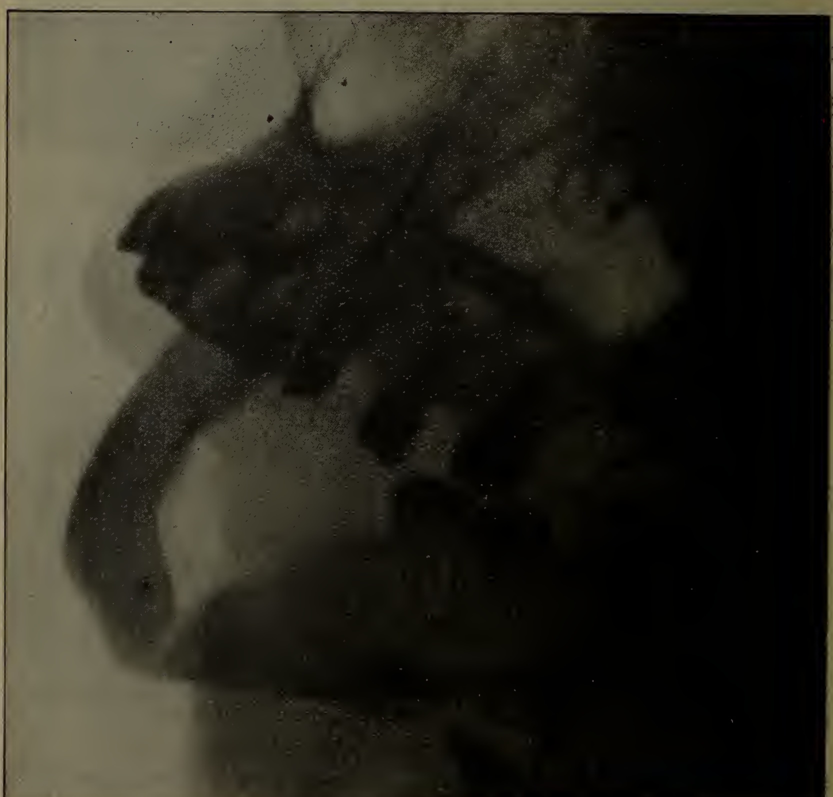

FIG. 877.[1]

[1] From *British Dental Journal*.

was adjusted consisting of a vulcanite cap covering the lower gums and attached to a metal cap splint on the upper teeth. The condition of the bone four months after the commencement of treatment is shown in fig. 877.

(*b*) *Fracture of the Molar Region with Loss of Tissue.*—The following case is quoted because it is an excellent illustration of (1) the effects of the glancing shot on the bone; (2) the approximation of the fragments to obtain union; (3) fixation in a malposition; and (4) readjustment of the mandible to functional activity.

The bullet entered one inch behind the left angle of the mandible and emerged through the right side of the bone about midway between the angle and the symphysis and about midway between the lower border of the bone and the alveolar border. On admission, one month after injury, there was a sinus at the site of the exit wound, with a purulent discharge and a probe passed up the sinus met bare bone. The teeth present were:—

$$\begin{array}{c|c} 7654321 & 1234567 \\ \hline 7654321 & 1234567 \end{array}$$

The mouth was gagged open on the second molars. The skiagram showed comminution of the bone extending backwards to the second molar and forwards to the canine (fig. 878). The following teeth were removed[1] :—

$$\begin{array}{r|l} \overset{*}{8}76 & \\ \hline \overset{*}{8}76543 & \end{array}$$

The sinus was dilated and several fragments of necrosed bone were removed. The fragments were allowed to approximate. The left fragment passed across to the right, and the right or posterior fragment swung forwards. A skiagram taken at this stage showed that there was a gap between the fragments. A splint was then adjusted and the left fragment brought still further to the right to obtain contact with the right or posterior fragment. Good union followed within four months (fig. 879), and within one month of the removal of the splint the teeth on the left side of the mandible were in correct occlusion. A skiagram (fig. 880) taken one year after the injury showed perfect union.

(*c*) *Fracture in the Region of the Angle and Ramus.*—In many cases the patient's third molars have not erupted, and occasionally a fracture passes through the crypt of this tooth. For this type of case the following treatment is adopted: In the mandible, the

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[1] The * denotes that the tooth was unerupted.

FIG. 878.[1]

FIG. 879.[1]—Skiagram taken just previous to the removal of the splint, showing (*a*) the forward movement of the posterior fragment, (*b*) the deviation of the anterior fragment to the injured side.

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[1] From *British Dental Journal.*

second molar is removed and then the unerupted third molar. The necessity for removing the second molar may be questioned, but it must be remembered, firstly, that the removal of the third molar alone would entail considerable injury to the fractured area and, secondly, that the removal of the second molar allows the operation to be carried out with a minimum of damage to the bone. In the maxilla, the second and third molars are removed for the following reason: Where there is loss of tissue, the ramus moves forward and the soft tissues are brought into contact with the upper teeth. The result is that the patient, in order to obtain a "bite of comfort," involuntarily brings the mandible over to the injured side and the

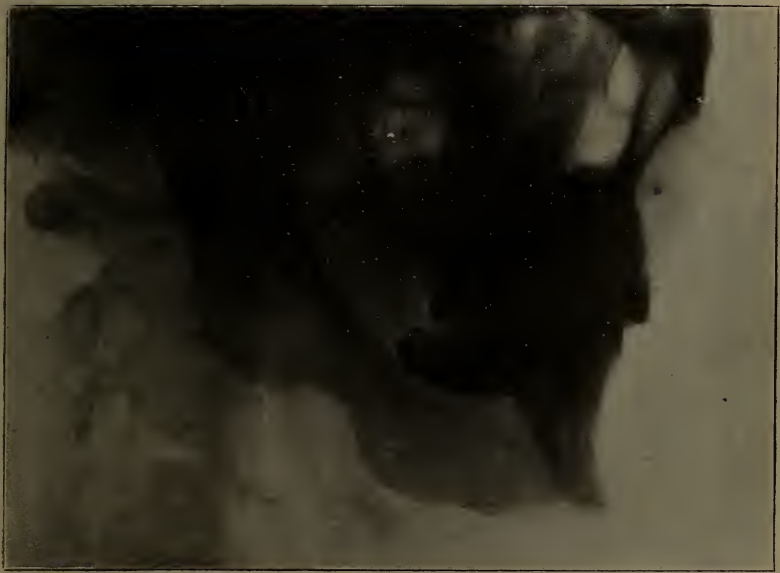

FIG. 880.—Skiagram taken one year after the injury, with dentures in position. The "imperfect bone" has been replaced by lamellar bone. The teeth are in correct occlusion.

teeth are not in occlusion; further, in many cases definite ulceration of the soft tissues follows. The removal of the second molar avoids this sequela. If the third molar is retained, a similar condition is likely to follow when this tooth erupts.

A patient was injured on July 1, 1916, and admitted to hospital on July 13. A bullet had entered half an inch above the right ala of the nose and emerged close behind the angle of the mandible on the same side. There was a deep flesh wound at the point of exit; all the teeth, with the exception of the left third molars, were

present; there was no mal-occlusion. The skiagram showed a severe comminuted fracture of the mandible and a fracture through the maxilla in the region of the molars.

The diagram (fig. 881) will help to convey an idea of the extent of injury to the mandible. The greater part of the ramus, as shown by the shaded area, was severely comminuted; the portion (*a*) was displaced backwards; there was a fracture running from the sigmoid notch downwards and backwards to the posterior border of the ramus; a thin layer of the posterior border (*b*) had escaped comminution.

At the operation it was found that the maxillary first molar was fractured into three pieces, and as the alveolar process carrying this and the remaining molar was quite loose it was removed. The mandibular first molar, which was septic, was also removed, together with the second molar and the unerupted third molar. The parts were frequently irrigated, and the patient made a complete

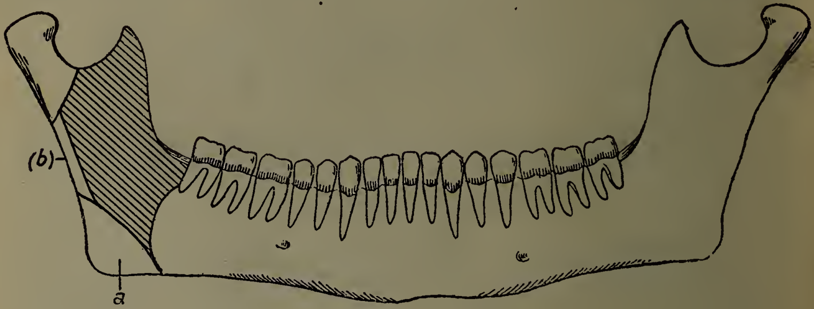

FIG. 881.[1]

recovery by October 15 when the occlusion of the teeth was as shown in fig. 882.

In severe comminuted fractures where it is doubtful whether the tissue remaining is sufficient to obtain union, the mandible should be brought into correct position and fixed for a period of at least three months. Early and efficient treatment of the sepsis produces exceedingly good results. An instance is given below.

The patient was injured September 11, 1916, and admitted October 2. The injury was caused by a fragment of shell which struck the mandible behind the right angle. The mandible had deviated slightly to the left; there was considerable swelling in the neighbourhood of the wound with a sinus freely discharging purulent pus. The skiagram (fig. 883) showed a severe comminuted fracture of the right ramus.

[1] From *British Dental Journal.*

On October 4 the following teeth were removed:—

$$\begin{array}{r|l} 876 & \overset{*}{4} \\ \hline 87 & \end{array}$$

The sinus, which was found to lead direct to the socket of the third molar, was scraped and several pieces of necrosed bone were

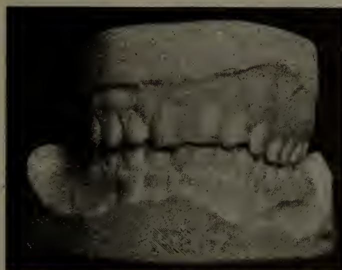

Fig. 882.[1]

Fig. 883.[1]

[1] From *British Dental Journal.*

removed through the wound in the mouth. The wounds continued to discharge freely, and it was not considered advisable to insert a splint until October 26. By the end of November the sinus had closed, and on December 7 the splint was fixed and not removed until February 12, when union was complete and the teeth were

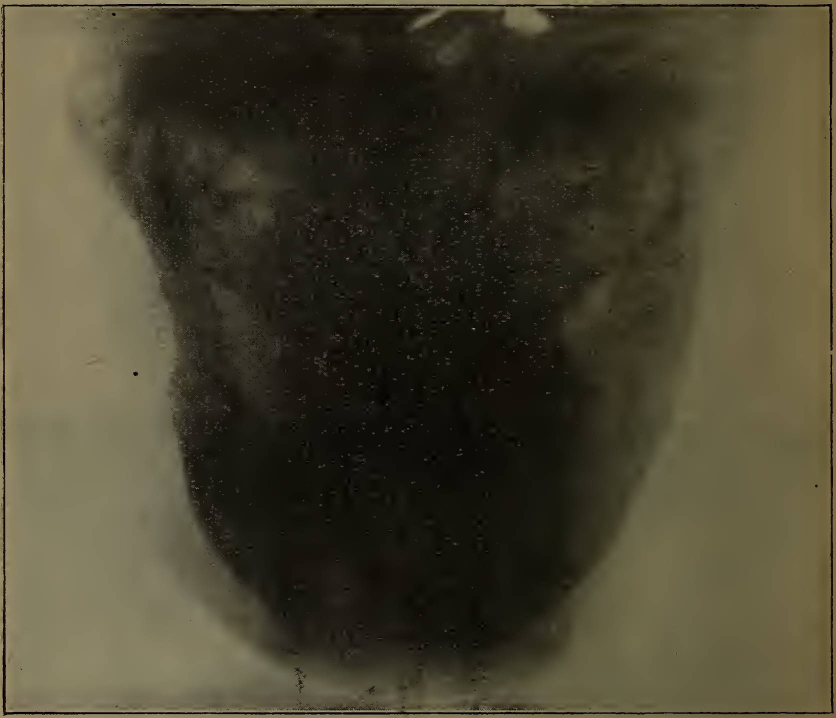

Fig. 884.

in perfect occlusion. A skiagram taken at this date is shown in fig. 884.

In cases where the loss of tissue is considerable the fragments should be united with a bone-graft.

CHAPTER XXX

Necrosis of the Jaws

Causes.—Signs and Symptoms—Diagnosis—Treatment

Necrosis affecting the jaws may be limited to a small fragment of the alveolar process, or may involve the greater part of the bone. Necrosis is more common in the mandible than in the maxilla, on account of the exposed position of the former, its smaller blood supply and the fact that it is composed mainly of compact tissue.

(A) CAUSES

(*a*) **Bacterial Poisons.**—In the majority of cases, necrosis of the jaws is the result of septic or infective processes arising in connection

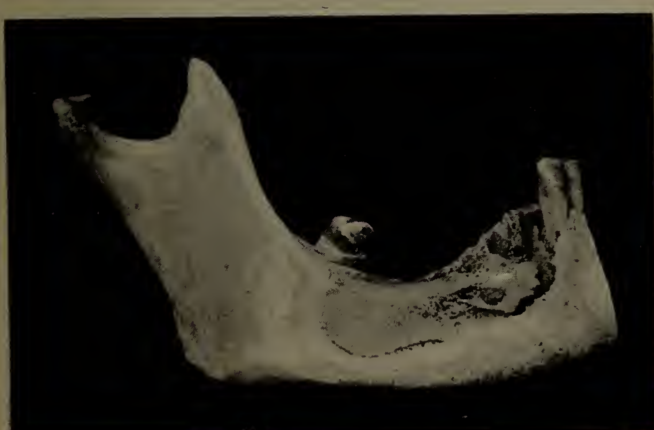

Fig. 885.—Necrosis of the mandible involving the body of the bone. The necrosis was due to sepsis in connection with the canine.

with the teeth. The *infection may reach the bone via the teeth* or their sockets, and examples of this are met with in the necrosis which occasionally follows septic periodontitis. The necrosis may be limited to the alveolar process, or may involve the body of the bone (fig. 885). How severe a condition can arise will be seen from

the following case reported by W. H. Dolamore.[1] It occurred in a little boy, aged 4, and arose in the region of the mandibular left deciduous molars. A general supporting treatment was carried out with the local use of antiseptic and deodorant mouth-washes. At the end of ten months the necrosed bone was removed, and the extent of the disease can be gleaned from fig. 886. The skiagram seen in fig. 887 shows the extent to which new bone had been formed from the periosteum.

A case is reported by Breward Neale,[2] in which an extensive necrosis of the mandible was attributed to a dental operation.

"The patient, a medical man, consulted a dental practitioner on account of great pain from a mandibular right canine in which

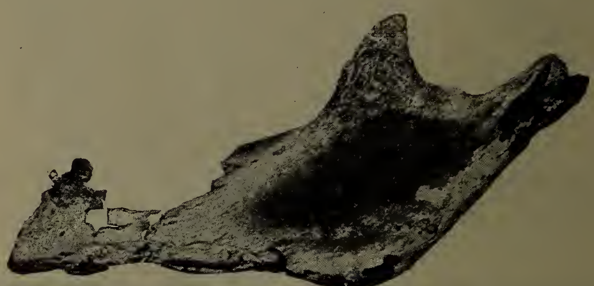

Fig. 886.[3]

the pulp was exposed. At the first visit the pulp was dressed with a devitalizing agent; at the second visit a portion of the pulp was extirpated; at the third visit the root and crown were filled, but a flexible drill was broken in the canal. The position of affairs was made clear to the patient, and he went away. On the fourth day he experienced great pain, and he attended and asked for the tooth to be removed, but as it was thought possible to save the tooth an opening was made through the alveolus with a view of relieving the pain. The patient attended the next day, again hoping to have the troublesome tooth removed, but the practitioner still thought removal of the root unnecessary, and excised the crown. On the sixth day, however, the root was extracted, but no relief following, the case passed into the hands of his surgical colleagues."

The patient then went into hospital. The pain and swelling increased and the submaxillary and submental regions became

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[1] *Journ. Brit. Dent. Assoc.*, vol. xxi, p. 3.

[2] *Trans. Odonto. Soc.*, vol. xxxii, p. 146.

[3] From *Journ. Brit. Dent. Assoc.*

swollen and brawny. Free incisions to the bone gave little relief. The condition became very grave, the whole mandible becoming involved as far as the angle and the outline of the neck being obliterated. The patient fortunately recovered, but, at different times, forty-nine sequestra were removed. The average size of the larger sequestra was 1 in. long, $\frac{1}{4}$ in. wide and $\frac{1}{16}$ in. thick.

FIG. 887.[1]

In children, whose resistance has been lowered by bad hygiene or acute illness, *the infection may reach the bone via the gum.* The necrosis seen in gangrenous stomatitis is an example of this mode of infection.

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[1] From *Journ. Brit. Dent. Assoc.*

A third way in which the *bacterial toxins may reach the bone is by the blood-stream.* H. A. T. Fairbank considers that infection through the blood-stream is more common than is generally supposed; the region of the angle and the ramus are the parts usually affected. The clinical condition is similar to "acute necrosis" of the long bones. Fairbank quotes the following case as typical of this type of infection: "A boy was brought to the Children's Hospital, Great Ormond Street, with a brawny swelling over the lower border of his mandible opposite the molar region. Each of the two deciduous molars on that side had a small carious cavity, though there was no sign of periodontitis, and the gums were normal. The swelling was incised through the skin and pus evacuated from beneath the periosteum of the jaw. One of the molars was removed, as it was possibly the cause of the trouble. Except for the superficial caries, the tooth was absolutely normal, and the pulp was healthy."

The necrosis, occurring as a sequela of the exanthematous fevers, is probably due to bacterial infection invading the bone from the mouth or the blood, and is in no way a specific effect of the fevers. The septic condition of the mouth present during the acute stages of the exanthematous fevers, combined with the lowered resistance of the individual, and the liability to injury in the process of cleaning the gums and the throat, all favour the occurrence of necrosis. H. Austen,[1] in an extended experience at the Western Fever Hospital, is of the opinion that necrosis always begins during the acute stage of the illness. In five thousand patients treated at the Western Fever Hospital, all of whom were under observation for at least eight weeks, the cases of necrosis that occurred could all be referred to the acute stage of the illness, not one having arisen during convalescence.

Necrosis is more common in connection with scarlet fever than with measles and is rarely met with in small-pox. In scarlet fever, necrosis is mainly met with in cases in which severe throat symptoms are present, and is usually first clinically recognized in the second and third weeks of illness. Children between the ages of 4 and 6 are the most frequent sufferers, but it may occur in younger and older patients.

Austen states that—

"Scarlatina necrosis of the jaw is most frequent in the lower incisor region on the labial side. It is, however, often seen in the premolar and molar regions on the buccal aspects. In the former

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[1] *Dental Record,* June, 1896.

situation it is usually symmetrical, less frequently so in the latter. In one case, under the care of a colleague, necrosis occurred on the inside of the ramus, well behind the last molar tooth, and not involving the alveolus in any way. The necrosis may involve the bone forming the sockets of the deciduous teeth only, or more rarely, and especially in the lower incisor region, cause destruction of the bone enclosing the sacs of the permanent teeth.[1] The sequestrum usually takes two or three weeks to separate. The mortality of the cases in which necrosis of the jaw takes place is high, partly from the usually intrinsically severe nature of these cases, partly from aggravation of the symptoms caused by the necrosis. In the worst cases, the mouth becomes horribly foul, and the patient soon dies of pyæmia or septic broncho-pneumonia. Two causes may be clinically recognized for this necrosis of the jaw in scarlet fever. Firstly, exposure of the bone by ulceration of the gum, seen in severe stomatitis, already alluded to. Secondly, and more frequently, injury. The latter cause may appear a somewhat remarkable one to anyone not acquainted clinically with this disease."

"For the efficient treatment of the very severe throat condition present in so many cases of scarlet fever, constant applications to the fauces (of antiseptics, &c.) become necessary, with removal of any secretions likely to decompose or lead to injury. This is done by syringing, spraying, or swabbing, the latter procedure being most effective. These methods, however, necessitate the introduction into the mouth of bone or vulcanite syringe nozzles, spatulas to depress the tongue, occasionally a cork wrapped with lint to gag the mouth open temporarily. However great be the care employed, it is almost impossible in some children to avoid injury to the deciduous teeth. The child will bite the spatula or the nozzle of the feeding vessel, &c., until the teeth become quite loose and fall out, the septic state of the mouth then causing ulceration, and ultimately necrosis of some part of the socket. I have been many times surprised at the very slight pressure with a spatula, or other implement used in examining the throat, that will loosen or extract the teeth in these cases, even when employed with the greatest care and gentleness. Even short of extraction of these teeth I am convinced from clinical observation that necrosis of the alveolus often arises merely from pressure on the crowns, and that not undue

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[1] It is possible that some cases where destruction of the permanent tooth sacs occurs may be overlooked, owing to the fact that the condition so often proves fatal.

in amount. In severe cases in which extensive necrosis appears, I am convinced that it is best to leave the fauces entirely alone, and to feed the child solely with the nasal tube, as if the treatment be persevered in the case will only go from bad to worse."

Austen's remarks have been quoted fully because they seem to throw much light upon this hitherto obscure condition. During the acute stage a piece of bone may die from either ulceration or injury, and may remain hidden beneath the gum for some time, the true condition only becoming manifest when the bone has separated from the living bone and is being exfoliated. Exanthematous necrosis so called would therefore seem to be not a secondary specific sequel, but rather a condition which arises during the acute stage.

(*b*) **Chemical Poisons.**—*Arsenious Acid.*—The commonest example of necrosis traceable to chemical poisoning is that which is caused by the escape of arsenious acid used for devitalizing the pulp. The poison may act directly on the gum, or may escape through the apical foramen. Usually, the necrosis is not extensive, but, with superimposed bacterial infection, a considerable portion of the bone may become involved.

Mercury.—A long course of mercury or the constant inhalation of mercurial fumes may cause necrosis. This form of necrosis is uncommon at the present day, as mercury is not now given in quantities sufficient to produce salivation, and operators employed in the manufacture of looking-glasses are not subjected to the same risks as formerly. Mercury causes necrosis by setting up an acute suppurative periostitis.

Phosphorus.—This form of necrosis was first described by Lorinser, of Vienna, while Wilks was the first in this country to draw attention to the subject. It is a severe form of disease and may affect both jaws, though usually only one at a time[1] is affected. In the early stages it is slow in its progress. The condition is one of cario-necrosis and differs in no respect from the same lesion seen in other bones and arising from various causes.

A mandible showing extensive necrosis due to phosphorus poisoning is shown in fig. 888.

This form of necrosis is nearly always seen in those subjected to the fumes of phosphorus. It is to be noted that the disease is mainly met with in those engaged in the dangerous parts of the manufacture of matches, namely, "mixing," "dipping," "drying," and "boxing."

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[1] In 51 cases collected by von Bibra, 21 occurred in the maxilla, 25 in the mandible, and in 5 cases both jaws were involved.

The fumes emanating from phosphorus consist principally of phosphorus anhydride (P_2O_3) and phosphoric anhydride (P_2O_5). These fumes are probably dissolved in the saliva. (1) The action may be purely local, in which case the irritant finds its way through a septic pulp or wound of the bone and sets up an inflammation of the periosteum, followed by suppuration and necrosis; or (2) the phosphorus fumes produce a general lowering of the resistance of the individual, and also locally, by their irritant action, weaken the nutrition of the bone and render it more liable to attack by micro-organisms.

The sequestrum from cases of this form of necrosis is often peculiar, owing to a deposit known as the "pumice-stone" deposit. This is found in sequestra from the mandible, but not in those from

Fig. 888.—Extensive necrosis of the mandible occurring in a lucifer match maker. In this specimen the "pumice-stone" deposit is not present in the sequestrum.

the maxillā. It is formed from the periosteum, but is so closely adherent to the sequestrum as to be generally brought away with it. A point of interest in regard to the structure of the deposit is that the Haversian canals are larger than in normal bone: they run at right angles to the general direction of the bone, and not parallel to it; they interlace with one another, and in some places form sac-like expansions. Although this peculiar deposit is generally to be found in cases of phosphorus, it may occur in other forms of necrosis.

The *symptoms* of this disease generally commence with toothache, which is at first local and constant, and later becomes more severe and erratic, the pain shooting to the side of the head and towards the shoulder. The disease is at first subacute. The gums

become swollen and livid, the swelling and tenderness increase, and suppuration eventually takes place. The skin over the part becomes red, tense, and distended. Bronchial and pulmonary symptoms from irritation may develop, while later, during the advent of suppuration, there is often well-marked pyrexia, accompanied by rigors. The sufferings of the patient are much relieved by the discharge of the pus.

Prognosis.—If the disease is not too far advanced and the treatment is prompt, the prognosis is favourable. In about 83 per cent. of the patients attacked with this disease recovery takes place.

The prophylactic treatment is the most important. The yellow phosphorus is the dangerous form, and its use is now abandoned in this country in match-making. Since the enforcement in lucifer match factories of special rules relating to general hygiene, regular medical and dental inspection, &c., the number of operators attacked by phosphorus necrosis has considerably decreased. In the years 1893 to 1899, previous to the institution of the special rules, thirty-seven cases of phosphorus poisoning occurred among 1,908 persons employed in the dangerous processes, while since the institution of the rules, namely 1900 to 1907, the incidence has been thirteen in 1,378.

(*c*) **Trauma.**—Necrosis from traumatic causes is only liable to occur when the injury leads to a comminution of the bone in such a way that the fragment is cut off from its blood supply. Necrosis of small portions of the alveolar process following extraction often occurs in this way. In the majority of cases of necrosis following trauma, however, the death of the tissue is due to septic infection.

(*d*) **Tubercle.**—Tuberculosis of the jaws is a rare and intractable disease. It is usually met with in patients affected with tuberculosis of the lungs. The disease usually starts in other parts of the mouth and spreads to the gums and teeth, more rarely the primary lesion is in the alveolar process. In a case under my care, the seat of trouble was a mandibular left second premolar, and the disease, in spite of treatment, involved the whole of the body of the bone on that side. An interesting case is recorded by Partsch[1] in which the primary lesion was a tuberculous periodontitis, the bacilli having gained access through a carious mandibular first molar.

Injury of the bone from tooth extraction in patients with active phthisis is liable to be followed by necrosis; the death of the bone

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[1] *Deutsche med. Woch.*, September 22, 1904 (translated in *Brit. Dent. Journ.*, vol. xxvi, p. 657).

may be due to the inability of the tissues to react to the injury, or to infection of the bone by sputum.

According to Carl Zandy,[1] tuberculosis of the alveolar process usually develops between the ages of 15 and 20, and affects males more frequently than females.

(*e*) **Syphilis.**—Necrosis from syphilis occurs in the tertiary stage, a common seat being the hard palate, but any part of the jaws may be affected. The primary cause is invariably injury to the bone from trauma, or sepsis; the part thus injured becomes the seat of a gummatous infiltration or a proliferative osteitis. The mandible is said to be less liable to syphilitic disease than the maxilla.

(B) SIGNS AND SYMPTOMS

Necrosis in the early stages simulates periostitis. The gums become much swollen and tender, and suppuration occurs, the pus discharging and leaving sinuses; the teeth become very loose and pus oozes up the sides. The skin may be shiny, red, œdematous, and the breath fœtid. In severe cases, gangrene may ensue, with fatal results.

(C) DIAGNOSIS

Necrosis is apt to be confounded with epithelioma of the gums which has spread to the maxillary sinus (creeping epithelioma), or it may be mistaken for sarcoma. Streptothrix infection also simulates necrosis. Dead bone can be recognized by the grating sensation produced when a probe, on being passed down a sinus, impinges upon the bone. In children, the sequestrum frequently involves the permanent teeth, while in cases of phosphorus necrosis it presents a peculiar appearance known as the pumice-stone deposit, which has already been referred to. After removal of the sequestrum in the maxilla, the tissue of repair is usually fibrous in character, no new bone being formed; whereas, in the mandible, a considerable amount of new osseous tissue is formed, and in a notable case recorded by W. Savory (*Roy. Med. Chir. Soc. Trans.*, vol. lvii, pp. 187-191) the whole jaw was removed from a lad aged 18, and six months afterwards, when death occurred, almost a new mandible had formed.

(D) TREATMENT

In the early inflammatory stages, any cause, local or general, should be removed and fomentations applied. A good purge must

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[1] *Arch. f. klin. Chir.*, iii, p. 178.

be given, and in addition, large doses of iodide of potassium are recommended, opium being added when there is much pain. Should destruction of the bone seem probable, free incisions must be made to relieve tension, while the teeth in the area involved should be removed. The health must be supported, and, if solid food cannot be taken, fluids must be given. If the bone is necrosed, but immovable, free drainage should be established and the case left alone for Nature to throw off the sequestrum. If more than one sinus exists, they should be connected and the parts constantly irrigated. As soon as the bone is loose it must be removed with suitable instruments. When the necrosis involves large portions of the jaw, surgical measures may be called for, but should not be adopted until the new bone developed from the periosteum is sufficiently complete to maintain the form of the jaw. For the method of procedure the reader is referred to one of the manuals of surgery.

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CHAPTER XXXI

Suppuration of the Maxillary Sinus—Empyema Antri

The Anatomy of the Maxillary Sinus—The Causes of Suppuration—Bacteriology—Signs and Symptoms—Complications—Diagnosis—Treatment

The chief disease of the maxillary sinus which comes under the notice of the dental surgeon is suppuration of the lining membrane.

(A) ANATOMY OF THE MAXILLARY SINUS

The maxillary sinus varies considerably both in size and shape, but these variations can be roughly grouped into three classes, namely, the normal, the small or contracted, and the large or expanded, the size being governed by the amount of tissue between the teeth and the floor of the sinus. The dimensions may be considered as **normal** when the floor of the sinus is approximately level with the floor of the nose; **contracted** when the floor is above, and **expanded** when the floor is below that of the nasal fossa.

The normal sinus extends from the first premolar to the tuberosity of the maxilla. The deepest portion lies opposite the roots of the second premolar and first molar, and from this point forwards and backwards the amount of bone between the teeth and the floor of the sinus increases in thickness. In the expanded sinus the amount of bone which covers the roots of the teeth is decreased, and the roots form projections on the floor of the cavity; the molar roots mostly forming these projections, the premolars less frequently. It is often overlooked that the third molar is closely related to the sinus, but the knowledge of this fact is of the greatest importance in treatment of cases where suppuration of the sinus is suspected to be of dental origin. In the contracted sinus, the amount of tissue between the teeth and the floor of the cavity is considerably increased.

The capacity of the sinus varies greatly. Those of small size may be capable of containing little more than 1 drachm of fluid; while those of the large size may hold as much as 8 drachms. The

two sinuses in the same individual may also vary considerably in size. The cavity in many cases is crossed by septa, which, as a rule, run along the floor, the most common situation being between the second and third molars. The septa along the floor may be continued up the outer wall, practically dividing the cavity into two parts.

The sinus may extend into the body of the malar bone. "Deep pockets or fossæ are met with in various parts of the cavity, particularly at the anterior and posterior corners and along the anterior wall immediately beneath the orbital plate. Sometimes a bony canal terminates in a *cul-de-sac* beneath the orbital plate in the nasal corner of the anterior wall." The average dimensions of the maxillary sinus are: Vertical height $1\frac{1}{2}$ in., transverse breadth 1 in., antero-posterior depth $1\frac{1}{4}$ in.

Normally the sinus opens into the middle meatus towards the anterior part of the cavity. In about 10 per cent. of specimens there is an accessory opening or possibly two. These accessory openings, which are usually situated further back and on a lower level, are, as a rule, larger and more circular than the normal ostium.

A. S. Underwood,[1] who has examined about 150 skulls of all ages and both sexes by transillumination, states that the sinus varies considerably in point of size and position, and suggests that its size and position may be entirely governed by the eruption, growth and subsequent loss of teeth. He finds that the molars and second premolars are almost always in relation to the cavity, the first premolar often and the canine rarely.

The relation of the teeth to the sinus depends on the size of the cavity. When the sinus is of exceptional size the canine may project in the floor of the cavity, while, in unusually small cavities, only the second and third molars are in relation with the floor.

Clinically, the size of the sinus may be gauged by the fulness of the facial and nasal walls. As a rule, the more these walls are depressed the smaller is the cavity of the sinus.

(B) CAUSES OF SUPPURATION

(*a*) **Trauma.**—Injury to the sinus from direct violence, such as a blow on the cheek, or from fracture of the bone, is seldom followed by suppuration unless a bacterial infection is superimposed. Cases of suppuration of the maxillary sinus in infants, reported to be the result of injury at birth,[2] are probably cases of acute osteo-myelitis.

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1 *Brit. Med. Journ.*, August 22, 1908, p. 463.

2 See case recorded by D'Arcy Power, *Brit. Med. Journ.*, September 25, 1897.

(*b*) **Bacterial Toxins.**—Injury to the mucous membrane by septic infection, either from the teeth or the nasal fossa, is by far the commonest cause of suppuration.

The Teeth.—The roots of the canine, premolars, and molars may project into the sinus, and, when this is the case, direct extension of a dento-alveolar abscess from any of these teeth may infect the lining membrane, but usually the second premolar and first molar are the offending teeth. Direct infection may be due to the penetration of a septic tooth or any other foreign body. The infection may arise from a dental cyst suppurating and opening into the cavity, but such cases are rare (see p. 517). One frequent source of infection, but one that is constantly overlooked, is from chronic general periodontitis (pyorrhœa alveolaris). In this condition the septic infection spreads from the periodontal membrane into the bone and thence to the cavity. In one case recorded by J. J. Kekwick[1] the tubercle bacillus was present in the pus, the local tuberculosis being started by a periodontitis in connection with a second premolar.

Opinions vary as to the relation which the amount of tissue between the roots of the teeth and the floor of the sinus bears to the liability to infection. Some authors consider that the thinner the bone the greater the liability to infection; others hold that the infection is due more to the infection of the bone generally than to direct extension from the teeth into the cavity.

The Nasal Fossa.—Extension of infection from the nasal fossa is the commonest cause of suppuration. The acute conditions which occur in the course of influenza and some of the exanthemata are probably due to direct extension of the infection from the nose.

(C) BACTERIOLOGY

K. Goadby[2] in a series of fourteen cases found various forms of staphylococci and streptococci, viz.:—

Staphylococcus aureus—seven cases.
,, *albus*—eight cases.
,, *citreus*—one case.
,, *viscosus*—two cases.
Streptococcus brevis—eight cases.
,, *longus*—one case.

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[1] *Brit. Journ. Dent. Sci.*, May 15, 1895.
[2] *Brit. Med. Journ.*, August 22, 1908, p. 465.

Of the other organisms identified, the *Bacillus fusiformis aerobius* was isolated twice, Friedländer's bacillus twice, and the *Saccharomyces neoformans* three times.

In acute suppuration of influenzal origin pure cultures of the influenza bacillus may be found. Tilley[1] states that "As a general rule a mixed infection is present, in which the *Diplococcus pneumoniæ* is prominent, together with the *Staphylococcus pyogenes aureus* and *albus*, *Streptococcus pyogenes* and *Bacillus coli.*"

(D) SIGNS AND SYMPTOMS

(*a*) **Acute.**—The most typical symptoms of suppuration of the sinus are seen after influenza. There is a feeling of intolerable distension of the zygomatic region, with pain of a throbbing character. The skin covering the bone becomes swollen, red, and very sensitive. Coughing and blowing the nose accentuate the feeling of distension by increasing the tension in the cavity. If the ostium maxillare is patent, there may be a discharge from the nose. The pain is most severe in cases where the opening is blocked, but it is at all times acute, as the inflammatory infiltration of the parts themselves produces pressure on the nerves. When the ostium is blocked an increased tension from pent-up discharge naturally increases the pain. General febrile symptoms are present.

(*b*) **Chronic.**—These cases are often extremely difficult to cure, may escape recognition for a long time. The most prominent symptom is discharge from the nostril on the affected side. A bad odour is at times noticeable by the patient himself, unless his olfactory powers have been blunted by nasal disease. Pain is not often severe and is not necessarily local. The pain may be referred to the frontal region or to the teeth, or may be felt over the affected sinus. The part may be tender and the patient unable in consequence to sleep on the affected side. There is generally some thickening and capillary injection of the soft parts over the affected sinus. Should the ostium maxillare become blocked when the pus has filled the cavity and is exerting pressure, the symptoms become acute. It must be remembered that pus under pressure in the sinus behaves precisely in the same manner as pus under pressure elsewhere, i.e., it finds an exit by the path of least resistance. There is no bulging of the walls or displacement of eyeball or alveolar process. Many cases presenting symptoms which have

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[1] "The Science and Practice of Dental Surgery," edited by Norman G. Bennett, p. 680.

hitherto been regarded as suppurating sinuses are really cases of suppurating cysts, mostly dental cysts.

(E) COMPLICATIONS

Suppuration in the maxillary sinus may lead to *necrosis* of its walls, to *infection of the sphenoidal sinuses*, or to *septic meningitis* through venous channels (deep facial and pterygoid plexus).

(F) DIAGNOSIS

In all cases of chronic suppuration there is some thickening of soft parts over the affected sinus; slight in many cases, but always noticeable. A purulent discharge from the nose, accompanied by a dull, deep-seated pain, is strongly suggestive of suppuration of the sinus. A diagnosis must be made from ozœna; in the latter, the breath is offensive to bystanders but not to the patient, while the reverse is the case in suppuration of the maxillary sinus. The presence of septic teeth in the molar or premolar region would assist in the diagnosis. Pain in the frontal region of one side (supra-orbital nerve) should always arouse suspicion of disease of that side; this pain is in some cases severe, even in the chronic types of suppuration.

The *presence of pus may be positively determined* by several methods:—

(*a*) Cleanse the nasal cavity, and place the patient in a position which brings the ostium lowest. If the ostium is patent, pus will trickle from the nostril. With a nasal speculum pus may be seen in the middle meatus.

(*b*) The *sinus may be punctured* by a trocar and cannula through the canine fossa or nose and washed out through the cannula so inserted.

(*c*) *Transillumination.*—Put the patient into a totally dark room and place an electric light in the mouth. Compare the two sides and note:—

(i) Whether the pupils are equally illuminated from within.

(ii) Whether the patient appreciates light equally on both sides (patients can usually answer the question intelligently).

(iii) The amount of light visible around the lower edges of the orbits.

(iv) The amount of light passing through the cheeks.

Conditions influencing Transillumination

Anatomical.—Transillumination is best seen in patients of spare build, whose palates and nasal fossæ are normal. The degree of

transillumination is lessened in cases where the sinus is small; where bony partitions are present; and where the palate is high.

Pathological.—The general transillumination is increased when a cyst is present which has caused thinning and expansion of the bone, provided that the contents of the cyst are clear. Transillumination through the pupil is obstructed in certain morbid conditions of the eyes, while general transillumination is diminished when (1) the sinus contains pus, mucus, &c., (2) the lining membrane is thickened as the result of a chronic inflammatory process, (3) solid growths are present in the cavity itself or invading it from without.

Transillumination is not an infallible method of diagnosis, but in combination with other methods it is one of great value. Errors are likely to arise in consequence of the varying thickness of the walls of the cavity in the same individual and the presence of suppuration in both sinuses.[1]

Occasionally the signs of suppuration are obscure, as illustrated by the following case[2]:—

"A female, aged about 55, very neurotic, complained of severe neuralgic pains of the left side of her face and head, of many years' standing—probably twenty at least. Her peculiar mental condition made it impossible to get a history or to trace any coherence in the distribution or occurrence of her pain. One point only stood out that she always began her tale of woe by reference to the left maxilla. The mouth was edentulous and all that called for note was a slight fulness of the left maxillary tuberosity, as compared with the right. There was no tenderness observable. Examination of the nose and antral transillumination were negative; a radiograph showed no sign of teeth. No treatment improved her, and eventually it was decided to explore the left tuberosity, influenced by the slight fulness and persistent reference of pain to that part. On opening up, the crown of a molar tooth was met with and its extraction was followed by a gush of muco-pus from the antrum. The roots of the tooth were almost absorbed and the remains of the periodontal membrane engorged, showing that the surrounding bone was inflamed."

In this case tangible signs were practically absent, the only indications of trouble being the persistent neuralgia and the tenderness and fulness of the left maxillary tuberosity.

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[1] See useful paper on "Transillumination of the Antrum of Highmore," by A. Brown Kelly, *Brit. Med. Journ.*, March 25, 1905, p. 650.

[2] Recorded by J. G. Turner, *Gazette of the Royal Dental Hospital of London*, vol. i, p. 49.

(G) TREATMENT

(*a*) **Acute.**—The treatment of suppuration in the maxillary sinus consists in giving free vent to the pus and thoroughly draining the cavity, as in the case of suppuration in other parts.

(i) If the cause is septic infection from a tooth, the tooth should be removed and the sinus perforated through the empty socket. The opening should be about a quarter of an inch in diameter; if made too narrow, considerable pain will be caused in inserting the nozzle of the syringe to irrigate the cavity. The instrument shown in fig. 889 will be found useful for perforating the bone. The

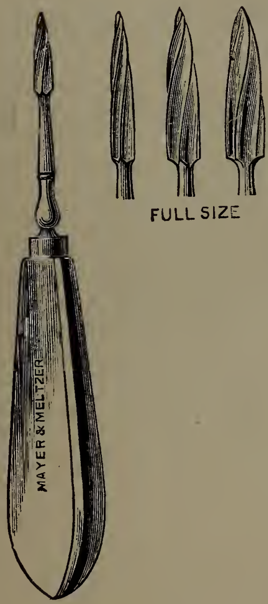

FIG. 889.[1]

passage should be kept patent by a vulcanite plug attached to a small denture. The cavity should be irrigated three times daily with about half a pint of normal saline solution or a weak solution of chloramine. With a lessening of the discharge of pus the irrigations may be reduced in number until the suppuration has ceased, but it is advisable that daily syringing should be continued for at least one week, the opening then being allowed to close. The irrigation is most conveniently carried out with a Higginson's enema syringe fitted with a suitable nozzle.

[1] For the use of this block I am indebted to Messrs. Mayer and Meltzer.

(ii) If the cause is nasal in origin, the sinus should be drained through an opening in the inferior meatus.

(*b*) **Chronic.**—The symptoms are often deceptive, and a case more especially when they arise from a nasal cause. There is a general consensus of opinion that the most satisfactory results are obtained by curetting the diseased mucous membrane and establishing intra-nasal drainage. For the technique of these operations the student should consult a work on "Diseases of the Nose."

Vaccine treatment has been used in cases which have not responded to drainage and lavage, but the results have not been satisfactory.

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CHAPTER XXXII

Tumours of the Jaw

It is proposed in this chapter to give a brief description of the more salient features of tumours of the jaw, with the object of assisting students to diagnose the swellings of the jaw, which may come under their notice.

(A) Innocent Connective Tissue Tumours

(1) Epulis.—This clinical term is broadly used to denote any solid swelling originating at the margin of the alveolar process. The growth arises from the periosteum of the bone or from the peri-odontal membrane and is found in any part of the alveolar process, but more frequently in the maxillary incisor region (figs. 890 and 891).

Fig. 890.—Mandibular canine with growth adherent to the periodontal membrane.

Fig. 891.—Mandibular premolar with growth adherent to the peri-odontal membrane.

These growths may be purely inflammatory in origin and in which case consist solely of granulation tissue; or, more rarely, the epulis may be of the nature of a true tumour and sarcomatous in character, the structure in some cases being that of a fibro-sarcoma and in others a mixed and fibro-sarcoma containing myeloid cells. The myeloid variety is not similar in character to the central myeloma of the mandible. "The giant cells lie in tissue composed of oval and round nuclei embedded in a distinctly fibrillar matrix, and there is a distinct tendency to fibrillation of the stroma, and in

this fibrillation the giant cells take a distinct part."[1] The malignancy is slight and recurrence, if it takes place, is local.

In a few specimens of epulis a development of myxomatous cells is seen (see fig. 893).

(2) **Fibroma.**—Tumours of the jaw composed of fibrous tissue may be either (*a*) periosteal or (*b*) endosteal.

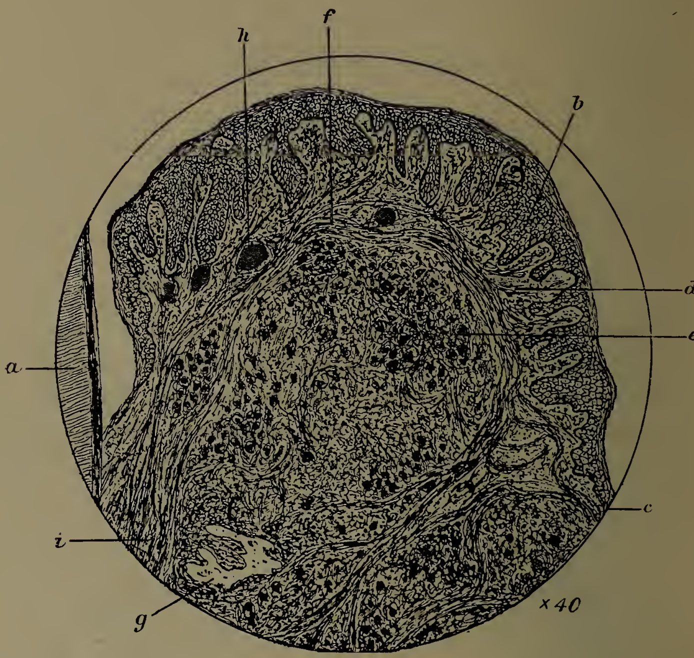

Fig. 892.—Longitudinal section of a growth similar in external appearance to figs. 890 and 891. *a,* dentine and cementum; *b,* stratified epithelium; *c,* basement membrane; *d,* submucous tissue; *e,* masses of giant cells; *f,* fibrous septa; *g,* nodule of bone; *h,* spaces filled with colloid material; *i,* attachment of tumour to cementum. (From a drawing by A. Hopewell-Smith.)

(*a*) **Periosteal Fibroma.**—This type of growth must be clearly differentiated from the epulis (see above). The true periosteal fibroma is composed of bundles of white fibrous tissue crossing one another in various directions and assuming a concentric arrangement in the periphery. The periosteal fibroma is usually pedunculated and of slow growth and may occur at any time from infancy up to adult life. The usual sites are in the mid-line of the mandible

[1] See "The Pathology and Treatment of Tumours of the Jaw," by F. Eve. *Brit. Med. Journ.,* June 29, 1907, p. 1525.

and in the premaxilla. These facts are suggestive of the origin of the growth. In the mid-line of the mandible they may arise

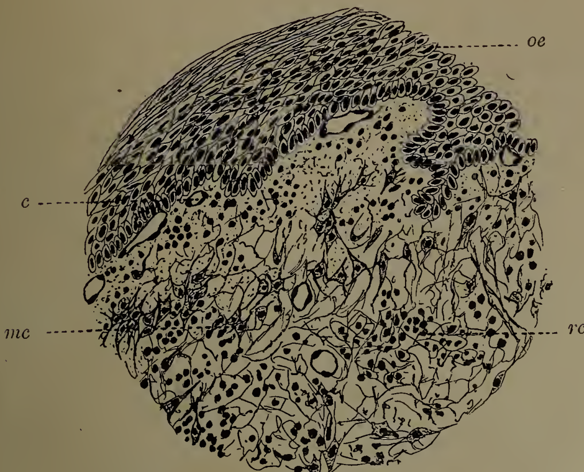

FIG. 893.—"Epulis" containing myxomatous cells. *oe,* oral epithelium; *mc,* myxomatous cells; *rc,* round cells; *c,* capillary. (From a drawing by A. Hopewell-Smith.)

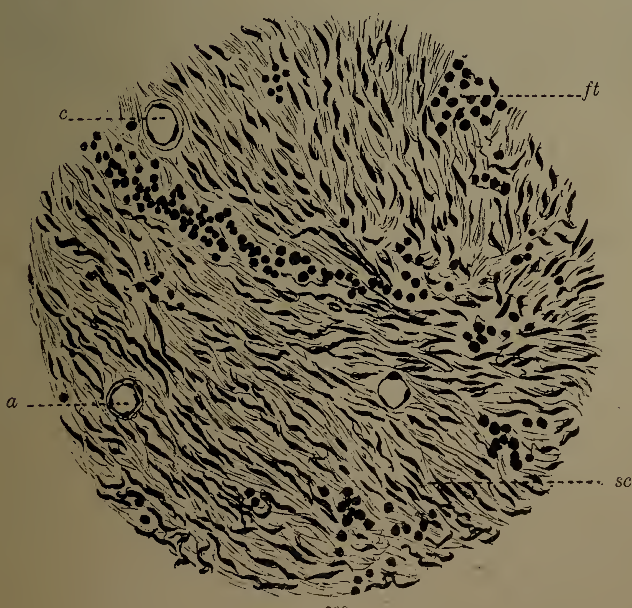

FIG. 894.—True fibroma of the gum. *sc,* spindle cells embedded in fine stroma of connective tissue fibres; *ft,* formative tissue composed of round cells; *c,* capillary; *a,* arteriole. (From a drawing by A. Hopewell-Smith.)

from some embryonic tissue or " rests " left at the time of fusion of Meckel's cartilage; in the premaxillary region they may be due to overgrowth along the sutures between the premaxilla and maxilla.

The microscopical anatomy of a true fibroma of the gum is shown in fig. 894.

(*b*) **Endosteal Fibroma.**—In the maxilla this growth is said to spring from the periosteum of the maxillary sinus. It is usually slow in growth and causes a gradual enlargement of the walls by pressure upon the thinner and more readily deformed boundaries —viz., the facial, orbital and nasal walls (fig. 895). In the

Fig. 895.—Fibroma of the maxilla arising in the maxillary sinus. (Museum of Charing Cross Hospital.)

mandible the endosteal fibroma causes a gradual expansion of the body of the jaw, and both the external and internal plate walls usually give way. The outline of the swelling is fairly regular.

Considerable interest centres round the origin of the endosteal fibroma of the mandible. J. H. Targett[1] gives an account of a small fibrous growth which was removed from the mandible of a boy aged 9. At the age of 7 he had sustained a blow on the chin, and six months afterwards a small swelling which steadily

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[1] "The Pathology of Certain Growths about the Lower Jaw," *Trans. Odonto. Soc.*, vol. xxxiv, p. 215.

increased was noticed in the jaw. On removing the swelling the mandibular nerve was found to pass through the middle of the tumour, the fibrous growth completely surrounding it. Targett is inclined to think that this and other cases of central fibromata of the jaw may originate in the sheath of the mandibular nerve.

It is possible that many of the cases recorded as endosteal fibromata belong to the category of fibrous odontomes. As an example we may quote the following case[1]: A female child, aged eight, presented an ovoid, elongated, smooth, hard and painless swelling of the right side of the mandible. The swelling extended forwards to within 1 in. of the symphysis and backwards beyond the angle of the jaw. The outer plate of the bone was principally bulged, the inner surface being but little altered. The soft parts over the tumour were quite normal, and the teeth behind the canine were missing. On removing the outer plate of bone, the tumour was found to be lying loosely between the plates of the jaw, and was shelled out with little difficulty, being held only at the lower and hinder part where it lay over a permanent molar tooth. This tooth was removed along with the tumour and was found to be attached to the tumour by a thin membrane. A careful examination showed that this delicate fibrous membrane passed from the outer surface of the tooth root to the delicate connective tissue capsule of the tumour.

(3) Chondroma.—Tumours composed of cartilage rarely occur in the jaw. In the maxilla, according to Heath, "The disease appears as a rule early in life, springing from the surface of the bone or from the antrum, and then making steady progress either externally or internally. The tumour produces absorption of the bone of the maxilla in its progress, and protrudes beneath the skin, which, however, it rarely involves."

In the mandible a chondroma may be endosteal or periosteal. The former type causes a gradual distension of the body of the bone somewhat similar to an endosteal fibroma; the latter type may grow to an enormous size, a specimen recorded by Heath weighing $3\frac{1}{2}$ lb. There is reason to believe that some of the cases recorded as chondromata are of a sarcomatous nature.

(4) Osteoma.—Tumours composed of bone form a most interesting group of jaw tumours. They may be circumscribed or diffuse. They may be composed of cancellous or compact bone.

In the maxilla the whole bone may be affected. An excellent

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[1] Recorded by Jordan Lloyd, *Journ. Brit. Dent. Assoc.*, August, 1898, p. 563.

example of this is shown in figs. 896 and 897.[1] The jaw is expanded generally, but more especially the facial surface. The outer compact plate is smooth except near the infra-orbital foramen, where the cancellous structure forming the tumour appears. Hancock, who removed this growth, refers to the fact that the bone

Fig. 896 —Osteoma of the maxilla. (Museum of Charing Cross Hospital.)

Fig. 897.—Section through tumour shown in fig. 896.

[1] From the Museum of Charing Cross Hospital.

"yielded to pressure to such an extent as to lead to some doubt as to its osseous nature."

Tumours composed of compact bone and of an ivory consistency have been recorded as occurring in the maxillary sinus. It is possible that many of these are really examples of odontomes. For example, the odontome described on p. 641 was originally considered an exostosis, but there is little doubt, from the clinical history of the case and the structure of the tumour, that it was in reality an example of a composite odontome.

Circumscribed osteomata growing from the facial aspect of the maxillæ are often symmetrical.

In the mandible the tumour formed of compact bone is the most common, but, occasionally, the cancellous variety occurs.

Fig. 898.[1]—A circumscribed osteoma growing from the angle of the mandible. (Bland-Sutton.)

Osseous growths of the mandible are sessile in the majority of cases. The commonest situation is the inner aspect of the alveolar process covering the premolar teeth. Other likely situations are the angle of the jaw (fig. 898) and the region of the mental foramen. The whole thickness of the bone may be affected, but such conditions are extremely rare.

Torus Palatinus.—This name is given to a thickening of the bone in the mid-line of the palate, which clinically simulates an osseous growth. The condition assumes various forms; in some cases the thickening extends almost the entire length of the palate and is symmetrical, as shown in fig. 899; at other times, it is

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[1] From "Tumours, Innocent and Malignant," by J. Bland-Sutton.

asymmetrical; while other examples may present the appearance shown in fig. 900. Sections of bones showing the torus palatinus are given in figs. 901 and 902.

Näcke[1] states that he examined 1,449 individuals, of whom 22 per cent. showed this deformity. He states that it is most commonly met with amongst the insane and criminals.

(5) Myeloma.—" A myeloma is a tumour composed of tissue identical in structure with the red marrow of long bones " (Bland-Sutton). The naked-eye appearance is characteristic—it is a maroon or dark red colour (fig. 903). Microscopical sections show them to be composed of spindle and round cells, with numerous giant cells more or less uniformly interspersed (fig. 904). They are always endosteal in origin, and, if completely removed, show no tendency to recur. They do not invade glands, nor disseminate by the blood-stream. Hence some writers place them in a class separate from sarcomata, under the name of myelomata.

In the maxilla they arise in the alveolar portion of the bone, or in the facial wall of the maxillary sinus near its junction with the alveolar process. In the mandible they arise in the body of the bone below the level of the teeth in the alveolar process. In both jaws the favourite situation is the region of the second premolar and first molar. They may arise in the premaxilla, or even in the hard palate.

Myelomata grow in a way somewhat similar to cysts. They tend to keep a more or less spherical shape and to bulge the walls which present the least resistance. The growth frequently makes its way to the surface via a tooth socket, and may be mistaken for a simple epulis. In the maxilla the growth may bulge into the maxillary sinus without invading the walls. In the mandible these growths give rise to painless swellings and tend to deform and, finally, in part destroy the outer plate long before the inner (fig. 905). When the swelling projects into the buccal cavity, its outline is not globular, as with a cyst, but presents slight undulations; it is solid and non-fluctuating.

In fig. 906 is shown the skiagram of a myeloma growing in the region of the mandibular right first molar. There was a history, six years before, of a difficult extraction, and the patient was unaware of any swelling in the jaw. This growth clinically simulated a dental cyst.

(6) Adenoma.—This form of tumour may arise in the soft palate or in the mucous membrane of the hard palate. Adenomata

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[1] *Neurol. Centralbl.*, June 15, 1893.

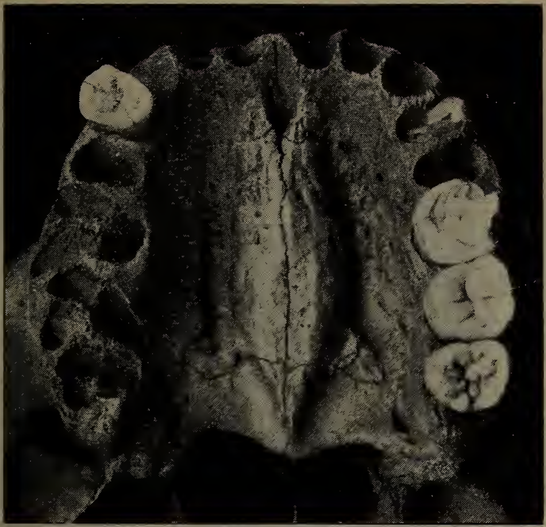

FIG. 899.[1]

FIG. 900.

[1] Figs. 899 to 902 are from a paper on the torus palatinus by Rickman Godlee, *Proc. Roy. Soc. Med.*

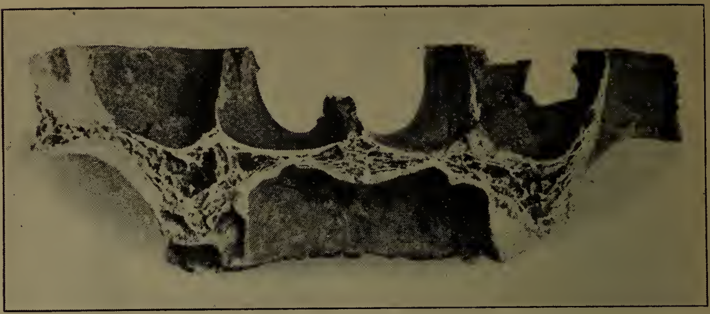

Fig. 901.—Section of fig. 899; the lower table as well as the diploe is thickened.

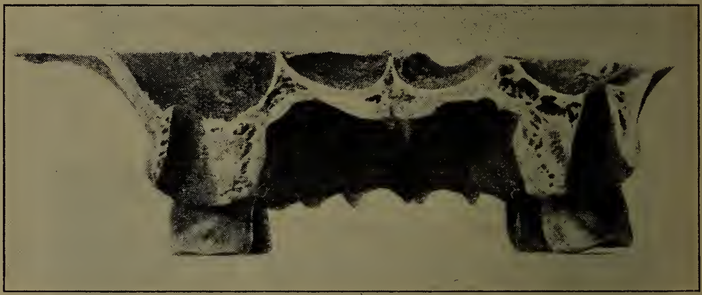

Fig. 902.—Section of torus caused by thickening of the diploe.

Fig. 903.[1]—Myeloma (myeloid sarcoma) of the mandible. (Heath.)

[1] From "Injuries and Diseases of the Jaw," by Christopher Heath.

FIG. 904.—Myeloma (myeloid sarcoma). *mc,* myeloid (giant) cells; *sc,* spindle cells, seen longitudinally; *bc,* blood corpuscles; *rc,* spindle cells, seen transversely. (From a drawing by A. Hopewell-Smith.)

FIG. 905.—Myeloma (myeloid sarcoma) of the mandible. (Museum of Charing Cross Hospital.)

are firm, slow-growing tumours which, on removal, shell out easily, but there are many departures from the typical adenoma and at times it is almost impossible to distinguish between the adenomata and the carcinomata.

There seems to be a tendency for some adenomata to become malignant. The following case[1] is instructive from the clinical aspect. "A female, aged 37, noticed a growth about the size of an almond freely movable under the mucous membrane of the hard palate. There was considerable lancinating pain in the tumour, and some carious teeth on that side of the mouth were removed, as they were considered to be the cause of the swelling.

FIG. 906.

There was a discharge of pus from the socket, and the swelling in the palate diminished in size but did not disappear. Three years subsequently the growth was incised, the dimension of the swelling then being an inch by half an inch. Ulceration followed, and the growth was then freely removed. Microscopic examination showed that it was an adenoma of the palate which had become malignant and infiltrating."

(7) Angioma.—These tumours, which occasionally occur upon the gums, may simulate a capillary nævus, in which case they are composed of dilated capillaries; a venous nævus is simulated when the tumours are composed of irregular spaces containing venous blood; and an arterial nævus, when the irregular spaces

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[1] See *Brit. Dent. Journ.*, vol. xvii, p. 181.

are filled with arterial blood. The microscopical appearances of an angioma are shown in fig. 907.

These growths usually present a smooth surface. They vary in colour, being bright red in arterial and purple in venous nævi; on pressure being applied they become pale, rapidly returning to their original condition after removal of the pressure. They are more common in the incisor region, though they may occur in the region of the molars. Starting as a little red spot, they gradually spread between the teeth and extend principally along the margin of the gum, both in front and behind the teeth. These growths bleed readily when touched with the tooth-brush, and in one case under notice the hæmorrhage was severe. In the case

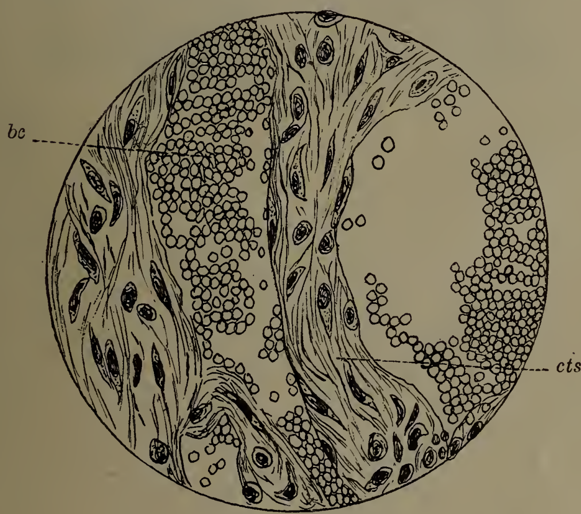

Fig. 907.—Angioma. *bc*, blood corpuscles; *cts*, connective tissue stroma.

of distinct venous nævi, the tumour may attain to a large size and involve the mucous membrane of the gum, cheek and lip.

Arterial angiomata are rare on the palate. A case is reported by Treves[1] of a small angioma about the size of a cherry situated between the two upper right incisor teeth. The angioma grew from the periodontal membrane and came away with the lateral incisor.

(8) Papilloma.[2]—Two varieties are met with, the pedunculated

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[1] *Journ. Brit. Dent. Assoc.*, vol. ix, p. 252.

[2] See "Papilloma of the Oral Cavity," by J. Arkovy, *Trans. Odonto. Soc.*, vol. xiii, p. 16.

and the sessile. The pedunculated are delicate polypoid growths and are always attached to the soft palate. The sessile or warty papillomata may be found in the muco-periosteum of the alveolar process or hard palate (see figs. 908 and 909).

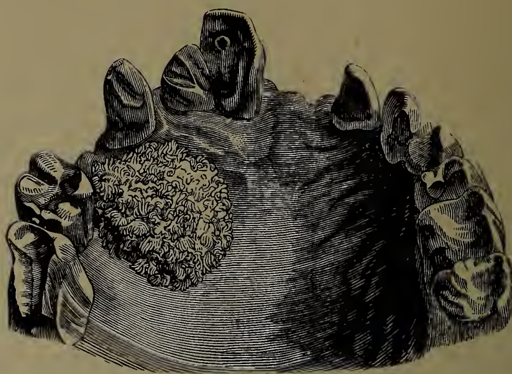

Fig. 908.[1]—Papilloma of the gum. (Heath.)

x 45.

Fig. 909.—Papilloma of gum (from a drawing by A. Hopewell-Smith). *a*, oral epithelium (stratified); *b*, sub-mucous tissue; *c*, rete Malpighii.

(9) **Myxoma.**—Pure myxomata are rare. A case of this type was reported by W. Daniels.[2] The patient, a woman, aged 27,

[1] From "Injuries and Diseases of the Jaw," by Christopher Heath.

[2] *Lancet*, December 12, 1908, p. 1747.

noticed a hard lump on the side of the mandible near the premolars nine months before coming under observation. The tumour was uniformly firm and hard; there was no fluctuation and no obvious swelling in the cheek. The tumour was readily shelled out, leaving a cavity in the bone extending through to the inner plate. The tumour was a pure myxoma.

(B) Malignant Epithelial Tumours

Carcinoma.—"The essential character of a cancerous growth consists in an unlimited multiplication of the epithelial elements of the organ attacked. In some cases this may result in the formation of a superficial outgrowth of a papillomatous type, while deep processes or columns of cells advance into the tissues along the lymphatic channels, and even burst through the basement membrane of glandular alveoli. The irritation of this development leads to an infiltration of the surrounding structures with round cells, which are presumably inflammatory in origin, by the agency of which the normal tissues are disintegrated and removed, and a stroma of variable density develops around the epithelial outgrowths. Hence all cancerous tumours may be said to consist of a fibro-cellular or fibro-cicatricial stroma within the alveoli of which are collections of epithelial cells, sometimes arranged in a methodical manner, but more often packed irregularly together and with no intracellular tissue between them. The alveolar spaces are in reality dilated lymphatics, and hence it is easy to understand that carcinomata are disseminated along these vessels; the cancer cells are epithelial in origin, and of very variable size and shape; but they always retain more or less the character of the epithelium from which they are originally developed, so that, e.g., a squamous epithelioma is never derived from a part covered with columnar epithelium, or *vice versa*. Blood-vessels ramify through the stroma, and are more or less abundant according to its density" (Rose and Carless).

Histologically, cancer consists of connective tissue containing alveolar spaces filled with epithelium varying in size, shape and arrangement. The alveolar spaces communicate with one another so that the growth of the epithelium is continuous. The connective tissue structure between the individual cells seen in sarcomata does not exist in carcinomata.

Maxilla

(*a*) **Squamous-celled Carcinoma.**—This always arises from the epithelium adjacent to the maxilla and, secondarily, invades the

bone. A common starting point is the margin of the gum, generally the outer aspect, adjacent to a tooth which has been the seat of long-continued sepsis. In such a case the chronic irritation from the tooth seems to have determined the growth of the epithelioma. This tumour may originate in the hard palate, where, in some cases, it may be traced to the chronic irritation of a badly fitting denture. The disease may also commence in the soft palate, the pillars of the fauces, the tonsil, and the buccal mucous membrane, and thence spread to the jaw-bone. Rarely it may happen that the irritation of the discharge from a chronic ulcer, primarily syphilitic in character, may cause a malignant growth of the

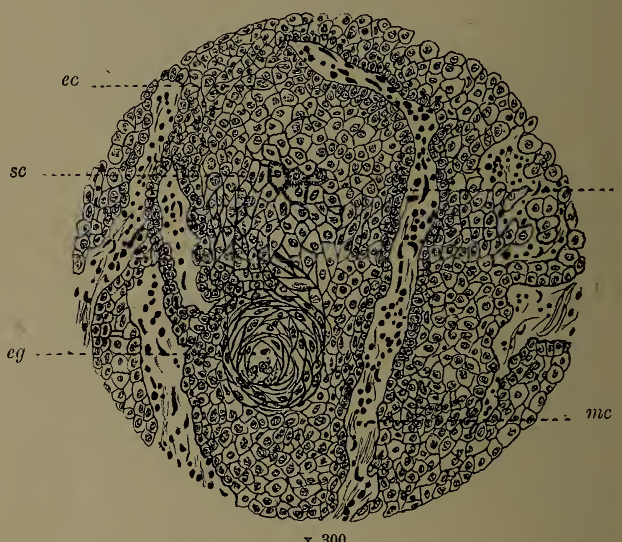

Fig. 910.—Squamous-celled carcinoma of the palate. *ec*, epithelial cells; *mc*, mesoblastic cells of submucous tissue; *eg*, epidermic globule of concentrically stratified epithelial cells; *ccc*, cylindrical cancer cells; *sc*, four "spiny" cells. (From a drawing by A. Hopewell-Smith.)

adjacent epithelium. This, a comparatively common sequence in the tongue, is very rarely seen in the maxilla, since chronic syphilitic lesions are uncommon in the mucosa covering it.

The squamous-celled carcinoma clinically may at first become evident as an ulcer. There is little doubt that in many of these cases a simple ulcer is present for some time in association with sepsis before malignant change occurs. If, after the removal of all source of irritation, the ulcer does not rapidly heal, it should be viewed with grave suspicion and immediately submitted to microscopy (fig. 910). In other cases the earliest sign of the

disease may be a nodule in the mucous membrane or a papillary excrescence. But whatever way it starts, an ulcer with more or less characteristic qualities soon appears. Its edge is hard, raised and tends to grow luxuriantly over the surrounding tissue, or, as is commonly said, is "everted." The surrounding tissues of the base are infiltrated; the floor is irregular, and may show irregular warty prominences and deep excavations at the bottom of which the bone may be exposed. The discharge from the ulcer abounds in cancer-cells. A characteristic feature is the extremely fœtid odour emitted from the growth. The ulcer spreads rapidly until a large tract of the jaw may be involved. Cervical glands are early enlarged, mainly by malignant deposits and to a lesser degree by chronic sepsis.

A curious form of squamous-celled carcinoma occurs in the upper jaw, to which the name "boring epithelioma" has been given. As the name implies, this type of cancer tends to burrow into the substance of the jaw-bone or even into the sinus, showing from the surface very little, if any, evidence of its grave nature. The onset of this disease is insidious, and the symptoms very indefinite. It often appears to originate in chronic sepsis, as the following case shows: A patient,[1] a female aged 35, had had suppuration in connection with a maxillary left lateral incisor for a period of two years. The alveolar process retained its natural contour; there was no swelling or redness, but about half to three-quarters of an inch above the neck of the tooth there was a sinus, the edge of which was not swollen but was covered with sodden epithelium. The tooth was loose and a little tender, and, on pressing the parts, a small quantity of thickish pus was discharged through the sinus. The tooth was removed with a little difficulty and adherent to it were ragged masses of tissue. On examination this proved to be epitheliomatous in character (fig. 911). At the operation the growth extended from the right central to the left first molar, and had only burrowed in the alveolar process, avoiding the maxillary sinus which was free.

(*b*) **Columnar-celled Carcinoma.**—This arises from the epithelium lining the maxillary sinus and the growth is primarily in that cavity. The growth tends to fill the cavity completely, and finally erode one or more of its walls and invade the adjacent soft tissues. When confined to the cavity, the symptoms are very indefinite and are generally those of a persistent and intractable neuralgia. At an early period, if the maxillary sinus were transilluminated

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[1] *Trans. Odonto. Soc.*, vol. xxxiii, p. 231.

from the mouth, opacity might suggest the cause of the neuralgia. Generally speaking, the symptoms are in abeyance until the cavity is filled with growth and pressure is exerted upon one of its walls. The growth may merely press upon the walls of the cavity and cause distension, or may erode through the boundaries of the cavity and infiltrate the soft tissues. For instance, the orbital plate may be pushed up, and perhaps some limitation of the movements of the globe of the eye may be seen; the facial surface may be encroached upon and a prominence of the cheek occur, with or without infiltration of the soft parts; or, should the posterior wall

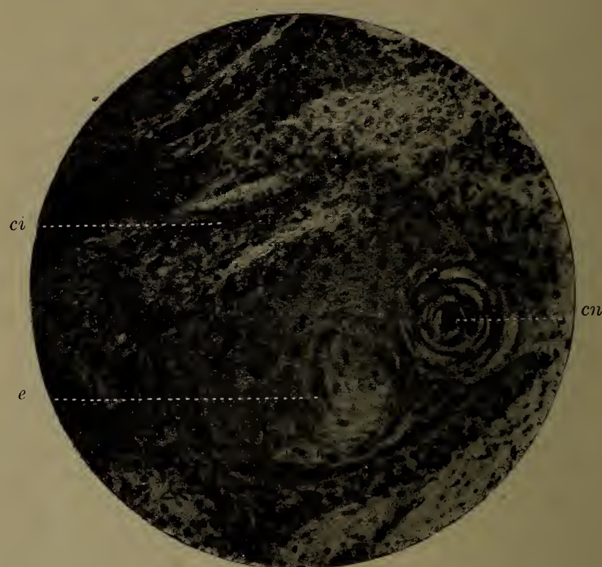

FIG. 911.[1]—*cn*, cell-nest; *ci*, small-celled infiltration of the tissues; *e*, islands of epithelial cells.

of the cavity be affected, a swelling may appear in the temporal region of the head above the malar arch. Inspection through the anterior nares may show a bulging of the inner wall of the maxillary sinus, or even a fungation of the growth into the nasal cavity. The teeth on the affected side may loosen and fall out, the sockets becoming filled with the growth. The cervical glands will sooner or later become enlarged.

Eve maintains that many of the growths of this type have

[1] From "Histology and Patho-histology of the Teeth," by A. Hopewell-Smith.

their origin from "rests" of the germinal epithelium of the teeth. (See chapter on Odontomes, p. 626.)

(*c*) **Spheroidal-celled Carcinoma.**—This may originate from the epithelium of the glands of the mucous membrane of the maxillary sinus. The growth exhibits the same clinical characters as the columnar-celled neoplasm of the maxillary sinus (fig. 912).

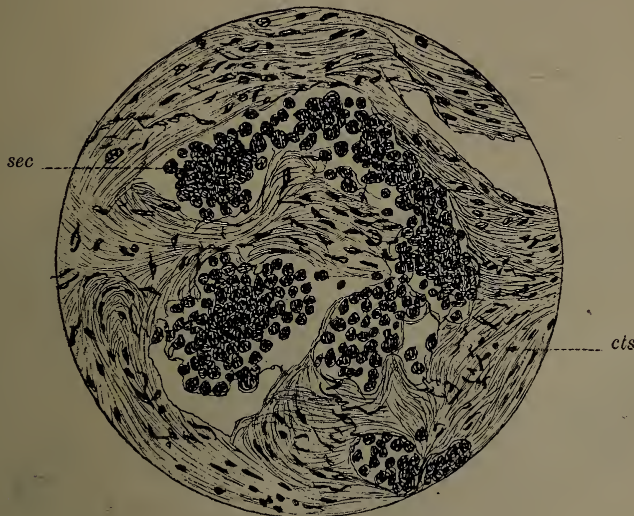

Fig. 912.—Spheroidal-celled carcinoma. *sec*, spheroidal cells; *cts*, connective tissue stroma. (From a drawing by A. Hopewell-Smith.)

Mandible

(*a*) **Squamous-celled Carcinoma.**—This type is most frequently seen. As in the maxilla, the growth arises from the adjacent epithelium, and, secondarily, invades the bone. It may originate at the gum margin, when chronic sepsis appears to play an important part in its causation; or it may commence in the floor of the mouth, the tongue, or the buccal mucous membrane, or the jaw may be secondarily invaded from the lower lip. However and wherever it commences, an ulcer speedily forms which has characteristics similar to those already described in the maxilla.

A squamous-celled carcinoma arising in the anterior extremity of the sublingual sulcus (sublingual carcinoma) is of importance to the dental surgeon, as the ulceration may be mistaken for a simple ulcer arising from the irritation of a denture. The disease starts as a small nodule, or warty ulceration, in the floor of the

mouth; ulceration follows and the disease spreads rapidly between the root of the tongue and the concave surface of the arch of the mandible. The surrounding tissues are speedily infiltrated; the tongue becomes fixed and the salivary ducts obstructed by pressure, or laid open by ulceration.

(*b*) **Columnar-celled Carcinoma** is very rare in the mandible. In all probability it originates in the "enamel organ rests" of the periodontal membrane, or in the body of the jaw. The growth causes an enlargement of the mandible before ulcerating into the cavity of the mouth.

The early recognition of carcinoma is most important, and, as it may come under the notice of dental practitioners in its

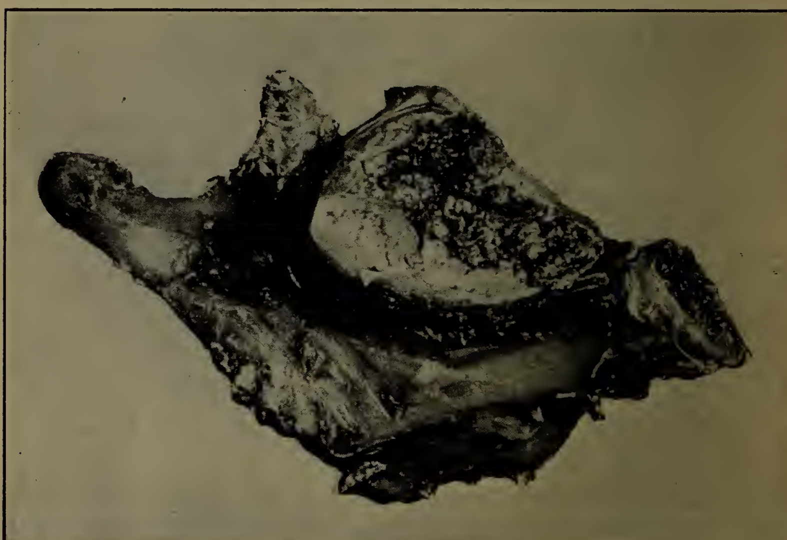

Fig. 913.—Squamous-celled carcinoma of the mandible. (Museum of Charing Cross Hospital.)

early stages, its clinical signs should be thoroughly understood by them. All patients over 30 with ulceration of recent origin should receive close scrutiny. The following is a typical history: A. B., aged 55, stated that two teeth in the maxillary left molar region became loose and fell out, and that he had since been troubled with a nasty taste in the mouth. An examination of the teeth sockets showed them to be filled with a carcinomatous mass. On another occasion, a man, aged 47, complained of pain in the maxillary left molar region. He had received a blow in this

region eighteen years previously, and the first and second molars had recently loosened and fallen out. The wound was filled with a mass of unhealthy-looking tissue, necrosed bone could be detected, and there was a profuse fœtid discharge. The patient had acquired syphilis twenty-five years previously. In this case, although the history was suggestive of a gummatous infiltration of the bone, the possibility of carcinoma could not be neglected. Microscopical examination showed merely granulation tissue. Under antisyphilitic treatment and local irrigation the condition cleared up.

(C) Malignant Connective Tissue Tumours

Sarcoma.—The term **sarcoma** is used to designate a tumour composed mainly of embryonic connective tissue cells. A sarcoma usually presents a homogeneous appearance, the colour varies and depends to some extent upon the vascularity of the growth. Sarcomata vary in their malignancy. Locally this group of tumours spreads by infiltrating the surrounding tissue, and eventually replacing it. A general dissemination throughout the body is brought about by the vascular system.

Histologically a sarcoma is composed solely of one type of cell, yet the type varies in size and shape; for example, the cells may be classed as large or small, round, spindle, oval. They are held together by a delicate reticulum, which, with suitable preparation, can always be demonstrated between the individual cells. The blood-vessels consist of spaces between the cells and are lined with a delicate endothelium. This peculiar arrangement of the vascular supply accounts for the extreme liability of sarcomata to hæmorrhage.

Patients suffering from sarcomata of the jaws are usually young —probably 40 per cent. of them are under 20 years of age. As in cancer, it is possible that chronic irritation plays an important part in their etiology. A definite history of previous trouble from the teeth can at times be obtained, and it is possible that in the past the relation of septic teeth to this type of malignant growth has been overlooked.

The round-celled, spindle-celled, fibro and mixed-celled sarcomata are met with in about equal numbers. Rare types are the embryo-plastic odontome, the melanotic, the chondro, the myxo, the osteo, and alveolar varieties.

Round-celled, spindle-celled, mixed-celled, and fibro-sarcomata may arise, either as periosteal or, more rarely, endosteal growths. These tumours may occasionally arise after injury, for example,

J. G. Turner[1] records a case where a man received a blow in the front of the mouth, which drove some septic incisors into the bone. Within a very short time he died of a small, round-celled sarcoma, which originated in the injured tissues. These varieties of sarcoma, when springing from the body of the bone, tend rapidly to invade the tissues and give rise to a distension of the bone in all directions, the arch of the teeth being considerably distorted. The periosteal type spreads with equal rapidity in all directions over the surface of the bone and extends down the sockets of the teeth, the bone

Fig. 914.[2]—A periosteal sarcoma. (Targett.)

itself being slowly eaten into by the growth, which, in the case of the mandible, may entirely surround it, before the centre of the bone is invaded.

Typical specimens are shown in figs. 914 and 915.

Microscopical sections of these growths are shown in figs. 916 to 918.

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[1] *Trans. Odonto. Soc.*, vol. xxxix, p. 112.
[2] From *Trans. Odonto. Soc.*

FIG. 915.[1]—An endosteal sarcoma. (Targett.)

FIG. 916.—Round-celled sarcoma. *rc*, round cells ; *cts*, connective tissue stroma ; *bc*, blood corpuscles ; *c*, capillary. (From a drawing by A. Hopewell Smith.)

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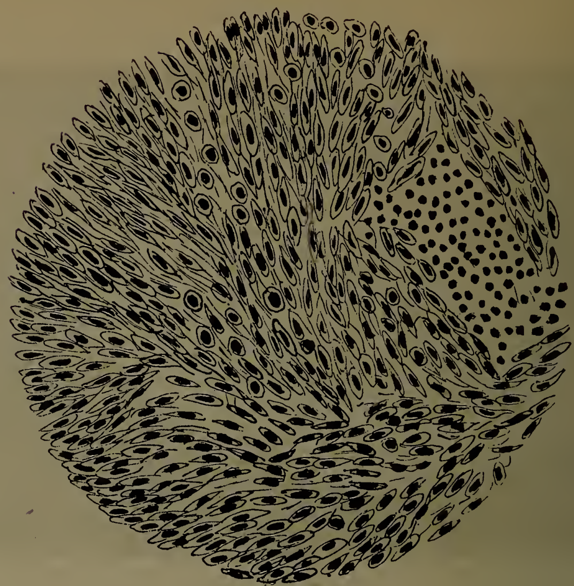
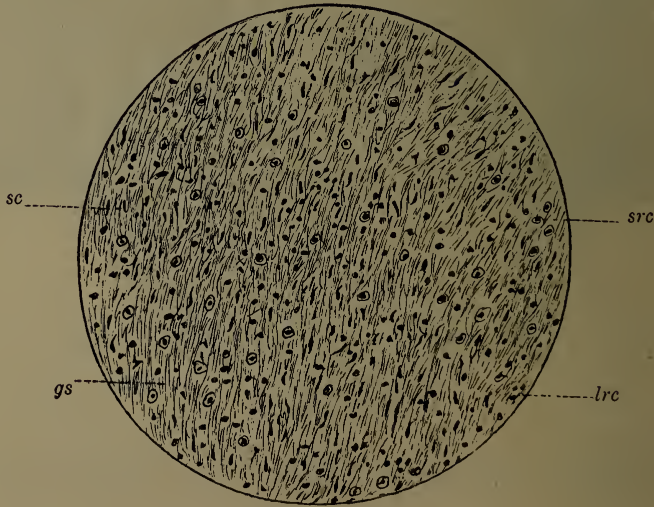
[1] From *Trans. Odonto. Soc.*



x 250.

FIG. 917.—Spindle-celled sarcoma. (From a drawing by A. Hopewell-Smith.) The cells are arranged longitudinally except in places, where they are transversely cut.



x 250.

FIG. 918.—Fibro-sarcoma. *sc*, spindle cells; *src*, small round cells; *lrc*, large round cells; *gs*, ground substance. (From a drawing by A. Hopewell-Smith.)

Fig. 919.—Microscopic characters of an endothelioma of the gum. (Bland-Sutton.)

The sarcomatous embryoplastic odontomes have been referred to under "Odontomes."

(D) Endotheliomata

Endotheliomata are tumours which arise in connection with the blood- and lymph-vessels. In the jaws they usually grow from the mucous membrane of the palate and are sometimes met with in the alveolar process. The microscopical features of an endothelioma are shown in fig. 919.

CHAPTER XXXIII

Diagnosis of Swellings about the Jaws

SWELLINGS of the jaws are not always easy to diagnose, and it is often impossible to determine the exact nature of the growths without making a preliminary incision or puncture.

(A) SWELLINGS INVOLVING THE MAXILLA

For convenience these swellings will be considered under: (1) Those involving the maxillary sinus; (2) those originating in the alveolar process; and (3) those growing from the palate.

(1) Swellings involving the Maxillary Sinus.—A tumour may arise primarily in the maxillary sinus, or a growth, having its origin in the alveolar process, may involve this sinus secondarily.

In order that the clinical features of swellings of the maxillary sinus may be clearly understood a brief reference must be made to certain points in the anatomy of that sinus. The sinus may be regarded as a closed cavity, the boundaries of which, with the exception of the one formed by the alveolar process, are thin and yield readily to pressure. A distension of the cavity is therefore a sign of the presence of a growth. Expansion (1) of the facial wall, probably the least resistant, leads to a swelling on the face situated under the lower border of the orbit; (2) of the orbital wall, to pressure symptoms on the eye, often accompanied by protrusion of the eyeball; (3) of the nasal wall, to obstruction of the nasal passage; (4) of the posterior wall, to pressure on the contents of the zygomatic fossa. The floor of the sinus formed by the alveolar process is of considerable thickness, and distortion of this wall as a rule only occurs in cases of malignant disease. The second division of the fifth nerve (superior maxillary) is in close connection with the sinus, entering at the spheno-maxillary fissure, traversing the infra-orbital canal, and opening on the face at the infra-orbital foramen. Implication of this nerve in a growth may give rise to persistent neuralgia before symptoms of distension of the sinus are apparent. The bony walls of the nasal duct, which are partly formed by the maxilla, may be invaded, leading to

pressure on the duct, which is shown clinically by epiphora (overflow of tears).

(*a*) **Swellings arising primarily in the Maxillary Sinus.**—The *only fluid swelling* primarily arising in the sinus is the condition known as "cystic disease of the antrum." This gives rise to a slow but painless distension of the walls. The thinner or facial wall gives way more readily than the more resistant, and the bulging on the face is therefore one of the most prominent symptoms. The swelling itself is smooth and globular, and, on pressure, may give rise to the sensation known as "parchment-like crackling." The alveolar border is not, as a rule, interfered with. In some cases the patient is aware of the presence of fluid in the sinus.

With *innocent solid tumours* there is a gradual distension of all the walls of the cavity, with the exception of the alveolar border. Epiphora may be present and severe neuralgia.

Malignant tumours give rise to a rapid distension of the facial, orbital, and nasal walls of the cavity, the alveolar process being involved in the later stage. Severe pain is frequently associated with malignant disease; the skin is implicated at an early stage, and œdema of the face is present. The lymphatic glands do not become enlarged until the growth is well advanced.

(*b*) **Swellings involving the Maxillary Sinus Secondarily.**—The sinus is frequently involved secondarily by tumours originating in the alveolar process. These tumours will be described under the next headings. Such swellings do not usually lead to distension of the cavity unless the growth attains a considerable size.

In *diagnosing between the swellings of the maxillary sinus* it is of primary importance to determine whether the growth is fluid or solid. This point may be determined by transillumination. The period of growth will enable innocent growths to be differentiated from malignant growths, a rapid growth suggesting malignant trouble. The rate of growth of tumours of the jaw is, however, not always easy to ascertain, the patient frequently being quite unconscious of the presence of any swelling in the mouth, and in other cases the swellings are not recognized until long after their appearance. The history given by a patient of the rate of growth must therefore be accepted with caution.

The solid innocent tumours occurring in the maxillary sinus are: (1) Fibroma, (2) enchondroma, (3) osteoma, (4) myxoma. The differential diagnosis of these tumours is at times far from easy, more especially in the early stages, as they all give rise to distension of the walls of the sinus. Osseous growths are generally exceed-

ingly slow in development, while fibromata and enchondromata may grow at times with great rapidity.

The malignant tumours occurring in the maxillary sinus are: (1) Carcinoma, (2) sarcoma. The differential diagnosis between carcinoma and sarcoma can sometimes be arrived at from the age of the patient; growths in the young are invariably sarcomata, while those occurring in persons over the age of 40 may be either sarcomata or carcinomata. A tendency to hæmorrhage will indicate a sarcoma; and growths springing from the region of the malar bone are nearly always sarcomatous. In the case of malignant tumours a diagnosis should always be made from necrosis, especially when there is a large amount of inflammatory material and sloughing of the soft tissues. In doubtful cases, a portion of the diseased tissue should be microscopically examined before an operation is performed.

(2) Swellings originating in the Alveolar Process.—These may be divided into (*a*) those growing from the soft tissues covering the bone; (*b*) those growing within the bone.

(*a*) *The usual growths springing from the surface of the bone* are the various types of epulides and the true fibroma. Their diagnosis presents but little difficulty. The epulides spring from the margin of the alveolar process, usually from the septum between two teeth. The possibility of the growth being an excrescence from a tumour involving the body of the bone must always be considered. This condition is seen more particularly in connection with myeloid growths.

The true fibroma can be recognized by its slow growth, and its frequent attachment to the bone by a pedicle (see p. 816).

(*b*) *The swellings growing within the alveolar process* are the most important from the point of view of dental practice. These may be divided into fluid and solid.

The fluid swellings are:—

(1) Acute abscess.
(2) Chronic abscess.
(3) Dental cyst.
(4) Follicular odontome (dentigerous cyst).
(5) Epithelial odontome.

The solid swellings are:—

(1) Fibroma.
(2) Myeloma.
(3) Calcified odontome.
(4) Sarcoma.
(5) Carcinoma.

In diagnosing between these growths the fluid swellings must first be separated from the solid. Fluid swellings are indicated when fluctuation is present, and when the swelling is regular, smooth, and globular in character.

The differential diagnosis of the fluid swellings lies between chronic abscess, dental cyst, follicular odontome, and epithelial odontome. The teeth should be carefully examined, and, if septic teeth are present, the probability is that the swelling is either a dental cyst or a chronic abscess. The differentiation between these will be assisted by considering the history of the swelling. In the case of a dental cyst there is a history that the swelling has slowly but progressively increased in size; with a chronic abscess there may be a history of rapid swelling and of variation in size from time to time. The swelling from a cyst is usually more defined, and the fluctuation is more elastic in character than in the case of a chronic abscess. If, however, septic teeth are absent the growth is probably either a follicular or epithelial odontome. With a follicular odontome a tooth is invariably absent from the series and the outline of the swelling is globular. With the epithelial odontome one or two teeth may be absent, and the swelling is frequently lobulated.

Fluid growths can be efficiently diagnosed from solid growths by the aid of skiagrams.

As regards *the solid tumours*, the rate of growth must be ascertained in order to determine whether the growth is innocent or malignant in type. The endosteal fibroma leads to distension of the outer alveolar plate; there is no fluctuation, and the character of the swelling is not globular in outline as it is in the case of cysts. A calcified odontome tends to produce a swelling similar to a fibroma. A myeloma usually leads to a distension of both plates of the alveolar process, the outer plate giving way more readily than the inner. The swelling is generally distinctly lobulated in outline, but this is not always the case, and in the early stages a diagnosis between a fluid swelling and a myeloma is by no means easy. Carcinoma should be suspected in all cases of rapidly spreading ulceration of the gums. In these cases the growth usually extends to the maxillary sinus and there is often no apparent swelling over the facial surface. In the later stage, however, the walls of the sinus become distended and the occlusion of the teeth disorganized. A fast-growing tumour springing from the outer aspect of the bone is usually a sarcoma.

(3) Swellings in connection with the Palate.—The commonest fluid swelling in the palate is a chronic abscess. It generally arises

in connection with the lateral incisor, but may be connected with a premolar or molar. The association of a well-marked fluctuating swelling with a septic tooth is sufficiently diagnostic. The possibility of the swelling being a gumma in the stage of breaking down must not be overlooked. The other fluid swellings that may occur are dermoid cyst (in the soft palate), follicular odontome, and aneurism of the descending palatine artery, but they are rare.

The solid tumours are: *Innocent*—(1) papilloma, (2) fibroma, (3) adenoma, (4) osteoma. *Malignant*—(1) sarcoma, (2) carcinoma. The papillomata are recognized by their characteristic appearance, but the possibility of the growth being an epithelioma in an early stage must not be forgotten. It is well to submit all papillomata after removal to microscopy. Fibromata may be recognized by their slow growth, their putty-like consistency, and in many cases their pedunculated character. Osteomata, in the form of so-called torus palatinus, are common. They are situated in the median line towards the back of the hard palate. Their extreme hardness and slow growth are sufficiently characteristic. Adenomata are rare. They give rise to solid sessile tumours and their true nature is often only apparent after operation, when they are found to shell out easily from the surrounding tissues. A fast-growing tumour springing from the hard palate is generally a sarcoma; from the soft palate a carcinoma. Here again the possibility of the swelling being a gumma must be considered.

(B) SWELLINGS INVOLVING THE MANDIBLE

With swellings in the neighbourhood of the mandible the first step is *to determine whether or not the swelling is in connection with the mandible*, and if it is, whether it involves the substance of the bone or is only connected with the bone externally.

(1) Swellings connected with the Bone Externally.—These include the various types of epulides. Their attachment to the margin of the alveolar process is sufficient to establish a diagnosis, but here, as in the maxilla, the possibility of the growth being simply an excrescence of a tumour involving the body of the bone must be kept in mind. The other solid growths arising from the external aspect of the bone are: *Innocent*—(1) fibroma, (2) enchondroma, (3) osteoma. *Malignant*—(1) sarcoma, (2) carcinoma.

Of the innocent growths the fibroma usually springs from the bone in the neighbourhood of the median line; the enchondroma and osteoma from the inner side of the alveolar process near the premolars or the angle of the jaw. Malignant growths springing

from the external surface of the bone tend rapidly to involve the overlying tissues, as is shown by the fact that the skin is adherent to the growth and not freely movable over the surface.

(2) Tumours involving the Body of the Bone.—The principal symptom will be gradual expansion of the two plates of the mandible, the outer generally yielding to a greater extent than the inner. Fluid swellings may be suspected when the bulging of the walls is quite smooth and globular in character; the outer plate may become so thin that, on pressure upon it, the sensation of "parchment-like crackling" may be felt. If the swelling is fluid, a diagnosis will have to be made between chronic abscess, dental cyst, follicular odontome and epithelial odontome. The mode of diagnosis between these has already been mentioned.

An epithelial odontome is likely to be mistaken for a myeloma, and the diagnosis between the two is often very difficult, but with the former there will nearly always be an absence of a tooth or teeth from the series.

With solid growths, the character of the expansion of the bone is not so regular as in fluid collections, the inner plate being involved as well as the outer. With innocent growths the swelling will be of long duration, while with malignant the swelling is generally nodulated and always of quick growth. The innocent tumours may be either fibroma, enchondroma, myeloma, or osteoma; the malignant either epithelioma or sarcoma. Necrosis must be carefully diagnosed from malignant disease, and the likelihood of mistaking a calcified odontome for more serious mischief must not be forgotten.

CHAPTER XXXIV

Interference with the Movements of the Temporo-Mandibular Articulation (Closure of the Jaws).

Cases of restricted movement of the jaws or closure of the jaws are frequently met with in practice. The treatment of these cases belongs frequently to the domain of general surgery, but it sometimes falls within the province of the dental surgeon. It is necessary therefore that the dental practitioner should be familiar with the various diseases which produce this condition and should be in a position to make a diagnosis.

(A) ETIOLOGY.

(1) Causes connected with the Teeth.—The commonest cause of closure of the jaw is infection in connection with a partially erupted or misplaced mandibular third molar. In this condition the tooth sac, which is partly opened, becomes filled with stagnant matter; infection follows and spreads through the periodontal membrane and thence along the sheaths of the muscles. The inflammatory exudation leads to a mechanical impediment to the movement of the muscles.

Infection around the second or first molars, or possibly infection around the maxillary molars, may spread to the soft tissues and cause closure of the jaws; but as a rule the interference with the movement of the articulation in these cases is not so marked as in the case of the mandibular third molar.

True spasm of the muscles from irritation of the nerves of the teeth is rare.

Chronic sepsis from the teeth may produce such an enlargement of the neighbouring lymphatic gland as to cause discomfort on movement of the mandible; this is particularly the case with enlargement of the lymphatic gland superficial to the parotid salivary gland.

(2) Tonsillitis.—In acute tonsillitis the infection may spread to the soft tissues covering the ramus and give rise to pain on opening the mouth. In these cases swallowing causes extreme discomfort; there is little or no swelling over the region of the face, but the tissues behind the angle of the jaw are usually swollen and tender to touch.

(3) Affections of the Parotid Gland.—Swellings of the parotid gland interfere with the free opening of the mouth by causing mechanical obstruction. The commonest cause of such swellings is an inflammation of the gland (parotitis) which may be a specific (mumps) or secondary to infection in the mouth, which has spread up the duct. Another cause, but less common, is the presence of a tumour. Swellings connected with the parotid gland are situated below and in front of the ear, and the socia parotidis can usually be felt lying over the masseter. In mumps the condition is usually symmetrical.

(4) Spasm of Muscles.—Closure of the jaws from spasm of the masseter and other muscles is very rare. The muscular spasm is said to be due to irritation of the pulps of the second and third molars, but I have never seen a case of closure of the jaws which could be attributed to this cause. Spasm of the muscles occurs in the course of tetanus and strychnine poisoning.

(5) Diseases of the Articulation.—In *acute arthritis* there is swelling in the neighbourhood of the joint, the parts are tender to touch and any attempt to move the joint causes great pain. In that form of chronic arthritis known as *osteo-arthritis* the movements of the joint are mechanically limited by the formation of new bone around the joint surfaces. In the early stages there is only slight stiffness of the jaw, which is more in evidence in the morning. When the mouth is being opened, a clicking sound is audible to the patient and also to the surgeon. As the disease progresses, the stiffness of the jaw increases until, in advanced cases, the articulation becomes practically fixed, owing to alteration in the shapes of the articular surfaces. Osteo-arthritis may be suspected when a patient of forty years or upwards declares a history of gradual loss of power to open the mouth.

In *osseous anchylosis* the jaw is absolutely fixed, but in fibrous anchylosis a slight movement of the jaw can be obtained. There is usually a history of injury or infection of the joint.

In the rare condition known as *hypertrophy of the condyle* there is usually some restriction in the movement of the joint; the enlarged condyle can be felt on palpating the parts over the region of the joint; the chin is pushed to the opposite side and the face is distorted on the affected side.

(6) Cicatrices.—After severe ulceration, scar tissue may be formed to such an extent that the movements of the mandible are considerably restricted and even complete closure of the jaws may arise from this cause. The scar tissue which forms on the healing of wounds of the elevator muscles of the mandible invariably prevents the mouth from being opened to its fullest extent,

the restriction of movement being most marked in the case of injuries to the tendon of the temporal muscle.

(7) **Tumours which press upon the jaw from without** may occur in the parotid or sub-maxillary regions, or in the situation of the deep cervical glands along the border of the sterno-mastoid muscle. *Deep-seated malignant tumours* may also lead to interference with the mobility of the jaw. Cases of this character are recorded by Coleman, Tomes, and others. This condition may be suspected when, after careful examination, other causes of immobility of the jaw have been eliminated.

(8) In a few cases the immobility of the jaw may be due to *exostosis of the zygomatic arch, ossification of the pterygo-maxillary ligament.*

(B) DIAGNOSIS

The diagnosis of the causes giving rise to closure of the jaws is best carried out by a process of elimination. The more common causes should be considered first, and these may be taken in the following order: Inflammatory infiltration of the tissues—the most frequent cause being dental, and then, possibly, mumps; arthritis; mechanical impediment from growths; mechanical impediment from scar tissue; hypertrophy of the condyle; and, lastly, rare conditions such as exostosis of the zygomatic arch.

(C) TREATMENT

If the trouble is dental in origin an anæsthetic should be administered, the mouth forcibly opened, and the offending tooth or teeth removed. Some difficulty may be experienced in opening the mouth, but a Mason's mouth-gag is generally effective. When the degree of trismus at first precludes the use of this instrument, the mouth can usually be forced open by a graduated wedge or spiral cone of boxwood. Instruments for forcibly opening the mouth must be employed with great care. After the extraction of the tooth the socket should be frequently irrigated and the pain relieved by fomentations. Complete recovery of the free movement of the jaw will often rapidly follow treatment, but in severe cases immediate recovery is not to be looked for. Where the third molar is concerned and it is not practicable to remove it, extraction of the second molar may give relief.

If the trismus is due to acute arthritis, wedges should be placed between the molar teeth and a four-tailed bandage applied in order to separate the articulating surfaces and relieve them from pressure. Fomentations should be applied over the region of the condyle.

In osteo-arthritis the treatment in the early stages must be constitutional rather than local. The patient should be advised to avoid exposure to the weather as far as possible. For patients who must necessarily be much in the open air a cap with folds to tie over the region of the joint should be recommended. Some relief may be obtained by careful massage of the joint and by rubbing in sulphur ointment over the affected region. In the more advanced stages, when the jaw has become more or less anchylosed, the operation of excision of the condyle or section through some part of the ramus may be practised.

Osseous and fibrous anchylosis require for treatment the formation of a new joint; while for hypertrophy of the condyle excision of the joint may be necessary. If the closure of the jaw is due to cicatricial bands considerable benefit may follow the excision of the scar bands and periodical stretching of the tissues by means of a specially constructed mouth-opener. Fig. 920 illustrates

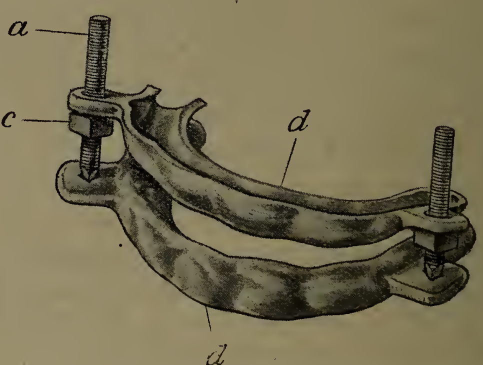


Fig. 920.

a useful form designed by L. Guanziroli. It consists of shallow metal caps (*d*) covering the surfaces of the upper and the lower teeth. On either side of the lower cap square-shaped holes are made for the lodgment of the square-shaped tapering ends of the upright bars (*a*); by this means some play is obtained at the end of the bar. The upper part of each upright bar is threaded and passes loosely through holes in the upper cap. The apparatus is opened by moving the screws (*c*).

Exostosis of the zygomatic arch and ossification of the pterygo-maxillary ligament are best treated by the formation of a new joint. If the trismus is due to external swelling, the treatment consists in seeking for and, if possible, removing the cause of the swelling.

CHAPTER XXXV

Some Common Affections of the Tongue met with in the Course of Dental Practice

Certain diseases of the tongue, more especially carcinoma, may first come under the notice of the dental surgeon, and it is most important that these diseases should be at once recognized by the practitioner.

(A) CHRONIC SUPERFICIAL GLOSSITIS: LEUCOPLAKIA

This disease is practically confined to the papillated portion of the tongue. It is an inflammatory condition of the mucous and submucous tissues, with certain changes in the surface epithelium, which not infrequently progress to the formation of carcinoma. The disease is produced by some continued irritation, such as smoking, strong spirit, the habitual use of strong condiments, and chronic dental sepsis. It is very frequently seen in persons who have had syphilis, appearing as a late manifestation and uninfluenced by antisyphilitic treatment.

The disease does not affect the tongue uniformly, but occurs in patches. The earliest evidence is shown by a portion of the tongue becoming smooth, which is due to the disappearance of the papillæ. The epithelium becomes thinned, and the part affected presents a smooth reddened appearance, contrasting very noticeably with the adjacent papillated tongue. This is often known as the *red glazed patch*. Further changes in the epithelium cause the patch to assume a pearly bluish-white appearance. Such a patch is quite characteristic; it is perfectly smooth, and will be slightly depressed below the adjacent papillated area of the tongue. This is the typical *leucoplakia*. Both these appearances may be present on the same tongue, and the patches vary considerably in size and distribution.

At this stage there is no real pain, and hence, before advice is sought, the disease has probably been in existence for some months or years. The tongue may feel uncomfortably dry and stiff. If precautions are taken (i.e., all sources of irritation are

removed and the tongue is kept scrupulously clean) patients suffering from the disease in this stage may have no further trouble. But too frequently an abrasion occurs in the thinned epithelium, bacterial infection ensues, and a *fissure* results. This is especially likely to happen on the borders of the tongue where friction is greatest, but fissures may occur in any of the patches. These fissures are extremely painful, and it is often at this stage that the patient first seeks advice. Under treatment fissures will often rapidly heal, but they frequently recur.

In some cases the disease does not progress further, but in others more serious changes develop. In a few cases the papillæ become much enlarged, and, proliferating, form a veritable tumour on the surface of the tongue. The name *ichthyosis* is given to this condition, and it is said that it always advances to cancer. Ichthyosis demands immediate and radical treatment. Far more common is the development of a *carcinoma*, either at the edge of a fissure or as a diffuse growth of the epithelium of one of the leucoplakial patches. A carcinoma demands prompt recognition and immediate treatment.

(B) ULCERATIONS OF THE TONGUE

(1) Simple. (*a*) *Dental.*—This is the most frequent type of ulcer of the tongue. The predisposing cause is the sharp edge of a tooth, or the rough edge of a denture. In some cases the ulceration is quite superficial, but, nevertheless, is very painful when speaking or eating. The surface is usually surrounded by a zone of inflammation. In other cases the ulcer extends deeper, the edges being irregular and abrupt, the surrounding mucous membrane inflamed, and the floor of the ulcer bathed with pus. The lymphatic glands may become enlarged from sepsis. When dental ulcers have existed for some considerable time the edges and base may become indurated, and in appearance the condition may mimic carcinoma. Not infrequently a carcinoma may develop at the site of a simple ulcer. If there is any doubt about the character of the ulcer its edge should be submitted to microscopy.

Treatment consists in removing the cause. Rapid improvement and healing generally follow, but if this does not occur a V-shaped portion of the tongue containing the ulcer should be excised.

(*b*) *Injuries from other Causes than the Teeth.*—Ulcers may arise from burns, bites, stings, &c. The history of the case gives the clue to diagnosis.

Treatment.—An antiseptic mouth-wash is usually all that is needed.

(c) *Dyspeptic* ulceration is most frequently met with near the tip of the tongue on the dorsal aspect. The ulcers are generally multiple and superficial, the portion of tongue around them being nearly always slightly inflamed, while symptoms of dyspepsia are present.

Treatment consists in attending to the dyspepsia, employing chlorate of potash mouth-washes, and, if the ulceration is very severe, brushing the surface of the ulcers with nitrate of silver.

(2) Infective. (*a*) *Syphilis.*—(*i*) A primary chancre is usually situated on the tip or the edge near the tip. It is characterized by the rapid formation of a hard nodule with superficial ulceration. The submaxillary glands are enlarged, and secondary symptoms of syphilis soon appear.

(*ii*) *Secondary.*—In the second stage of syphilis mucous tubercles may appear on the tongue. These tubercles consist of patches of enlarged and infiltrated papillæ, the superficial epithelium becomes soddened and gives rise to a characteristic yellow-white appearance. The surface of the mucous tubercles is liable to be injured, and ulceration of a septic type appears. The ulcer is therefore septic in character grafted on a syphilitic lesion.

(*iii*) *Tertiary.*—(*a*) *Deep intramuscular gumma* forming a nodule in the substance of the dorsum of the tongue. The swelling, which is painless, breaks down and forms a deep excavated ulcer. (i) The edges are sharply cut; (ii) the induration of the surrounding tissue rapidly disappears under treatment; (iii) the floor may present a wet washleather-like appearance, in the early stages before the slough has disappeared; (iv) the situation of the ulceration is usually the dorsum of the tongue immediately to one side of the median line; (v) the submaxillary lymphatic glands are not usually enlarged, in a few cases enlargement is due to sepsis; (vi) profuse salivation is not usually present; (vii) there may be pain, but usually not so severe as in epithelioma.

(*β*) *Multiple Superficial Gummata.*—These break down and form superficial ulcers.

(*γ*) *Fissures and ulcerations* in connection with chronic superficial glossitis.

(*b*) *Tubercle.*—Tuberculous ulceration of the tongue is generally secondary to tuberculosis of the lungs or larynx and is due to a direct infection from the sputum. The usual situation is the under-surface of the tip of the tongue. The ulcers are superficial, often multiple and very painful. A zone of inflammation is usually present around the ulcer, and, occasionally, caseation of the floor can be seen. The coincidence of the ulcers with usually well-

marked symptoms of tuberculosis of the lungs or larynx is sufficient to prevent the condition being mistaken for either syphilis or carcinoma. Occasionally, the clinical symptoms of the primary disease are not very obvious.

(*c*) *Actinomycosis.*—Ulceration from this cause is rare. A hard, brawny swelling of the tongue forms and breaks down, giving vent to a gelatinous-like discharge containing the characteristic granules. Microscopy shows the nature of the disease.

(3) Malignant. (*a*) *Carcinoma.*—This most serious disease of the tongue may start:—

(i) In chronic ulcers or fissures, dental in origin, and very commonly situated at the borders of the tongue.

(ii) As a warty outgrowth, with infiltration of the base and surrounding tissues.

(iii) As a nodule.

(iv) In association with chronic glossitis originating in an ulcer, fissure, or ichthyosis, or appearing as a diffuse infiltration.

The characteristics of a carcinomatous ulcer are as follows: (i) Raised, sinuous, hard and everted edges; (ii) the surrounding mucous membrane is indurated; (iii) the floor irregular, in part excavated, and in part showing warty prominences and covered with a foul discharge; (iv) the base indurated, and, in the latter stage, the tongue fixed; (v) a darting pain; (vi) profuse salivation; (vii) enlargement of the neighbouring lymphatic glands (not in the very early stages); (viii) interference with speech and mastication. The disease is more prevalent in men than in women, and occurs generally in those past the age of 40.

Treatment is excision of a portion or the whole of the tongue, and the whole lymphatic area in the neck.

As before stated, early recognition of the disease is of the utmost importance. The presence of a wart on the side, tip, or, indeed, any part of the tongue in a person over 35 years of age should always be regarded with suspicion, and the patient *at once* advised to seek skilled assistance. All ulcers of some standing should be submitted to a careful examination. The particular points to which attention should be directed are: (i) The history of the ulcer; (ii) the character of the edges; (iii) the condition of the surrounding mucous membrane.

Ulceration in patients over 40 is always serious, and in doubtful cases it is better to have the suspicious portion excised.

(*b*) *Rodent ulceration* is extremely rare, and scarcely needs description here, and the same may be said of (*c*) *sarcoma*.

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